

### MARYLAND UPLANDS NATURAL AREAS STUDY

### FIELD NOTEBOOK, WESTERN SHORE

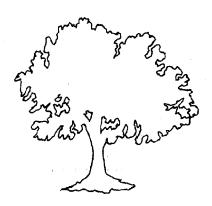
Revised 1976 by

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Prepared for

# COASTAL ZONE MANAGEMENT PROGRAM

Maryland Department of Natural Resources



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### **PREFACE**

The Maryland Upland Natural Areas Study was begun in the spring of 1975 and was designed to partially fulfill the requirements of the Coastal Zone Management Act of 1972. The original sampling methodology was designed by Rogers and Golden, Inc., for inventorying sites on Maryland's Eastern Shore. The fundamentals of this methodology are described in the opening chapters of this report. During the winter of 75-76, the methodology was revised to reflect our experience in the field the previous summer and to better adapt the methodology to the Western Shore.

A great effort was made to obtain input into the methodology from potential users of this study and from experts in the various subject areas for which sample information was to be obtained. This information was then synthesized into a sampling procedure. The sampling procedure was designed to enable field personnel to quickly obtain a concise, accurate characterization of each site. The sampling is not meant to be a substitute for the detailed site assessments needed for a final project evaluation but to provide a means of screening a large number of sites for specific uses.

Approximately 400 sites have been sampled on the Western Shore using this methodology, and the results of this inventory will be made available in computer format for potential data users. In addition, the sites will be evaluated based on the data collected for possible designation as critical areas of state concern.

The Field Notebook incorporated in this report represents the methodology developed by the Coastal Zone Management Program for sampling upland natural areas on Maryland's Western Shore. The notebook contains a description of the methods and techniques for data collection and is intended to serve as a manual for organizations or individuals who may be interested in carrying out field surveys of upland sites on the Western Shore.

# **ACKNOWLEDGEMENT**

This study was greatly aided by information and advice from many experts and professionals. Special thanks are due the following:

John Antenucci, Department of State Planning; Earl Bradley, Coastal Zone Management Program; Grace Brush, Johns Hopkins University; King Burnett, Maryland Environmental Trust; James Burtis, Forest Service; Nick Carter, Fisheries Administration; Howard Erickson, Towson College; Francis Golet, University of Rhode Island; Herbert Harris, Natural History Society of Maryland; Bernard Holla, Wildlife Administration; Lee Jaslow, Environmental Services; William Kramer, Capital Programs Administration; Randy Kerhin, Maryland Geological Survey; Steve Long, Power Plant Siting; Bruce Nichols, Soil Conservation Service; Maryland Park Service; Chandler Robbins, Patuxent Wildlife Research Station; Kenneth Ropp, Capital Programs Administration; Lewis Rudasill, Capital Programs Administration; Tom Siccama, Yale University.

As is apparent from the variety of people with whom we have worked, the study incorporates a diversity of disciplines. In bringing the various elements together, we have relied heavily on the knowledge and labor of the professional staffs of the Department of Natural Resources, the Department of State Planning, and the Soil Conservation Service as well as members of the scientific community. In addition, we have had the good fortune to be able to visit with many knowledgeable and interested residents of the Western Shore. We are grateful for the courtesies, hospitality, and kindness they showed us, as well as for their valuable insights.

The discussion of Aquatic Buffer Zones, included in the discussion of derived parameters in Chapter III, is part of an unpublished report undertaken independently of this study. It has been adapted and included for informational purposes. "Aquatic Buffer Zone" Copyright 1975 John W. Rogers, Stephan B. Syz, Arthur A. Sullivan. All rights reserved.

The permission of Francis Golet to include his paper "Classification and Evaluation of Freshwater Wetlands as Wildlife Habitat in the Glaciated Northeast" in this report is gratefully acknowledged.

During the summer and fall, the field crew stayed at several state parks while involved with the site inventory. We would like to extend special thanks to the Maryland Park Service, the park superintendents, and park employees for providing a temporary home and all of its amenities for our field crew.

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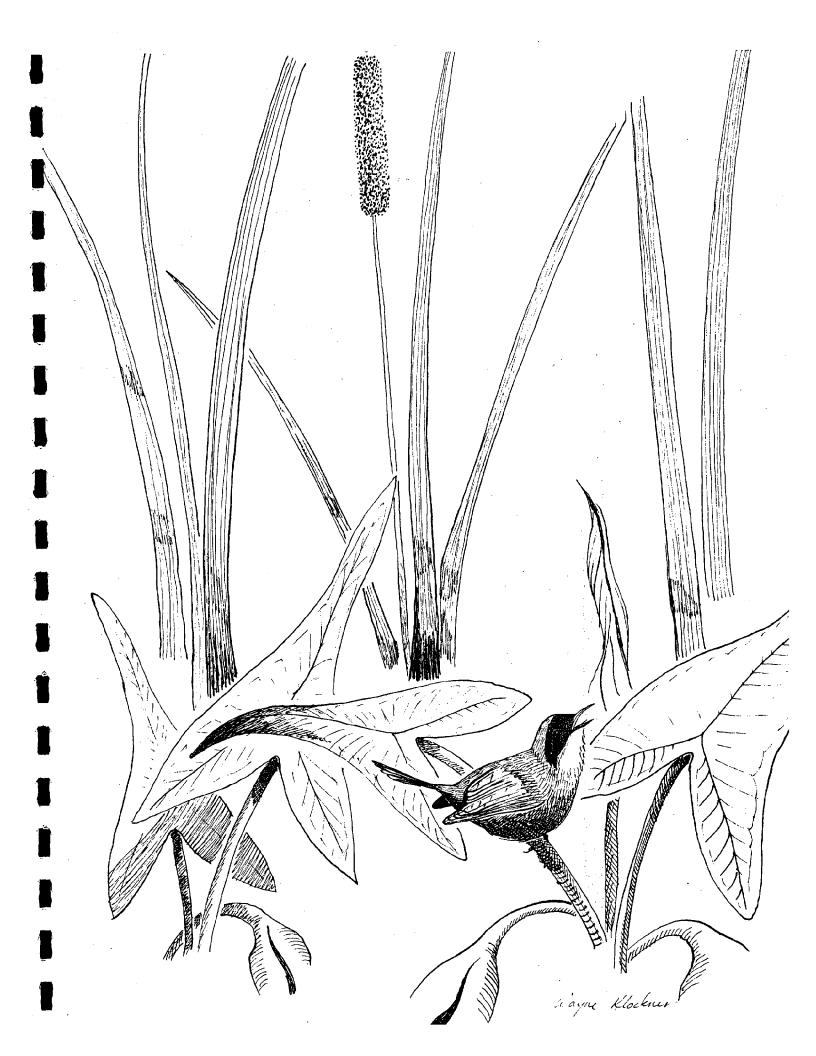
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# INTRODUCTION

The Maryland Upland Natural Areas Study is part of an ongoing effort by the Maryland Coastal Zone Management Program to describe and assess the resources of Maryland's coastal areas. The study was begun in 1975 with the goal of surveying all areas within the Coastal Plain which had been recommended as potential areas of critical state concern because of their floral or faunal characteristics. The Study provides objective and descriptive data on identified natural areas. This information will be used to describe and evaluate the inherent value of an area as a natural ecological unit and to ascertain its value for certain compatible uses.

For the purposes of this study, upland natural areas are defined as areas where, at present, natural processes predominate and are not significantly influenced by either deliberate manipulation or accidental interference by man. The majority of sites sampled include mature forests. wooded swamps, non-tidal wetlands, and stream corridors. Tidal areas were excluded from this study and will be subjected to a separate inventory and assessment.

The areas selected as candidates for field investigation were recommended by a broad range of published and unpublished sources. These sources are described in the parameter descriptions section under the heading, "Bibliography". The candidate areas fall into at least one of the following categories:

- 1. Areas with unusual or interesting natural features meriting protection by the state or local government,
- 2. Areas crucial to an ecological system which should be protected from inappropriate development or use,
- 3. Areas considered a primary state resources, and
- State owned lands such as open space and parks. (See Table 1)

The study's sampling methodology was developed with two basic goals: (1) to provide a consistent data base so that areas could be compared, and

(2) to enable the characterization of many sites quickly and accurately.

An initial step in this study was to identify potential data users and their specific needs. Those users with a continuing and timely need are state agencies and departments with both functional and regulatory responsibilities. Prior to data gathering, these users were involved in the design of the information system. Department of Natural Resources personnel, state and local planners, and knowledgeable persons in related fields were interviewed about data needs to make the study as broad as possible (See Table 2). From an analysis of the data users' needs, the

functions and scope of the study were established. As a result of these interviews and a literature search, the sampling parameters for the natural areas study were determined. Table 3 is a listing by field data form of parameters which were found to be important to the study.

The major product of the Upland Natural Areas Study is a computer storage file from which specific natural area data can be quickly retrieved. This data management system makes the data more useful by increasing its accessibility to the users such as state agencies, county planners, and private citizens. The data management system was designed with two main purposes: (1) to check the data for miscoding errors and (2) to print the data in an easily readable format. As designed, the management system will also allow retrieval of individual site descriptions or retrieval by individual parameters or groups of parameters. This will allow users of the data to objectively rank areas by evaluating the different parameters in the context of their importance to potential site uses. Wherever possible, the data format has been made compatible with the Department of State Planning's MAGI System. An example of a computer print-out is shown on the following pages.

The report that follows is organized into several sections. First, the survey procedure and coding process is described. This is followed by the detailed parameter descriptions and encoding instructions for filling out the field data forms. These descriptions and instructions are organized by data card as shown on the sample field data forms under the section marked "Coding". The remaining portion of the report entitled "Readings" contains study area descriptions, glossary, and other pertinent information.

In summary, the important features of the Study are:

- The sampling methodology is set before field work begins. This
  is important for consistency and uniformity of the data collected,
- 2. The methodology is designed to fulfill the information needs of potential users. Since the users were included in the development of the methodology, they are more likely to use the data collected by this methodology,
- 3. The sampling techniques are easily replicated so that new sites can be added and the study can be continuously updated,
- 4. The data is easily compared between sites, and
- 5. The natural areas information is readily accessible to potential users.

### Table 1: Areas Selected for field Survey

- 1. Areas which have unusual or interesting natural features meriting protection by the state or local government. These natural features might consist of:
  - a. Natural habitats supporting unique wildlife population or a species whose range is limited in the state or whose numbers are so limited as to warrant special consideration.
  - b. Natural areas possessing unique features such as:
    - 1. Sandy beaches or sand dunes.
    - 2. Bluffs having unusual exposed geologic strata or offering scenic vistas.
    - 3. Scarps.
    - Inland rivers having wild character, profuse blooming flora, unusual floral communities, or mature, regenerating forests.
    - 5. Forest communities with a species range limit such as bald cypress, laurel oak, loblolly pine or overcup oak.
    - 6. Endangered forest species such as chestnut or elm.
    - 7. Trees which are currently national or state champions.
- 2. Areas which are crucial to an ecological system and should be protected from inappropriate development or use. This category might include:
  - a. Streamside forests which buffer aquatic systems from upland contaminations such as silt, bacteria, and toxic chemicals.
  - b. Low wetlands which support many wildlife species, and perform such useful functions as water filtration, floodwater storage, and nutrient assimilation.
- 3. Areas which can be considered to contain a primary state resource. These areas include:
  - a. Natural wildlife habits of high productivity.
  - b. Areas of exceptional scenic quality.
- 4. State owned open space and parks.

### PEOPLE INTERVIEWED

Table 2

| Wildlife   |   |   |
|--|---|---|
| Nick Carter<br>Bernard Holla<br>Chandler Robbins | Fisheries Administration<br>Wildlife Administration<br>Ornithologist          | DNR DNR Patuxent Wildlife                           |
| Craig Ten Broeck<br>Francis Golet                | Wildlife Administration<br>Department of Forestry and<br>Wildlife Management  | Research Station<br>DNR<br>Univ. of Rhode<br>Island |
| Geology  |   |   |
| Randy Kerhin                                     | Md. Geological Survey   | DNR   |
| Vegetation                                       |   | ·   |
| Grace Brush<br>James Burtis                      | Geography Department<br>Forestry Service                                      | Johns Hopkins Univ.<br>DNR                          |
| State Planning                                   |   |   |
| John Antenucci                                   | Div. of Comprehensive<br>Planning   | Dept. of State<br>Planning                          |
| Recreation                                       |   |   |
| William Kramer<br>Kenneth Ropp<br>Lewis Rudasill | Capital Programs Admin.<br>Capital Programs Admin.<br>Capital Programs Admin. | DNR<br>DNR<br>DNR                                   |
| Environmental Services                           |   |   |
| Lee Jaslow                                       | Environmental Services  | DNR   |
| Coastal Zone Management                          |   |   |
| Thomas Chaney<br>William Jackson<br>Earl Bradley | Water Resources Admin.<br>Water Resources Admin.<br>Water Resources Admin.    | DNR<br>DNR<br>DNR                                   |
| Soil   |   |   |
| Bruce Nichols                                    | Soil Conservation Service   | USDA  |
| Natural Areas Studies                            |   |   |
| Thomas Siccama<br>Harold Erickson                | School of Forestry<br>Biology Department                                      | Yale University<br>Towson College                   |

# **PARAMETERS**

A list of parameters sampled on Western Shore natural areas follows in the order in which they appear on the data sheets which were completed for each area.

### Parameters

Card 1 Area Number
Area Name
Date
Nearest Town

Card 2 Elevation
Geology
Ownership
Bibliography
Current Use
Security
Access
Site Type
Integrity
Occurrence
Size
Average Width
Forest Edge

Card 3 Contiguous Land Use
Aquatic Buffer
# of Community Types
Community Diversity
Visual Experience Score
Visual Experience Term
Wetland Wildlife Rating
Categories
One Line Description

Card 4 One Line Description (continued)

Cards 5 Text

Cards 6 Names

Subsection Number Card 7 Similar Subsections Area of Subsection Waterbody Distance Waterbody Type Waterbody Size Waterbody Depth Waterbody Bottom Material Beach Type Beach Length Beach Width % of Stream Shaded Soil Type Soil Drainage Vegetation Type Topography Source of Disturbance Degree of Disturbance Passage Animals - species, source, residency, frequency

Card 8

Number of Samples

Total % Cover - canopy

Total % Cover - understory

Total % Cover - shrubs

Total % Cover - herbs

Vegetation Species

Average DBH

Layer

Impact
% Cover - species

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-MARYLAND DEPT. STATE PLANNING 1975 (UNPUBLISHED) THYENTORY
-OF MARYLAND CRITICAL AREAS.

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| #JOHNSONTOWN-SHIPPEN CREEK WOODS   | 150793333321505  |
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| TIDAL STREAM   | 0T + 30 ACRES + 1 F03T +   |
| SHADED<br>ANK<br>Y E SECONDARY   | DN SELECT CUTTING MOTOR VEHICLES   |
| TOTAL AVERAGE COVER BY LAYER C*60% U=70% S=40%   | ######################################   |
| KEY TO VEGETATION  LA-LAVER  C-CANDRY  U-INDERSTORY  | I ОВН LA VEGETATION COVI DBH  9-12 C AMERICAN BEECH 10 12-18  6-9 C 4HITE OAK. 20 12-18  6-9 C 1.08L0LY PINE 10 12-18  |
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# SURVEY PROCEDURE

The following section describes the technique to be used in the field inventory. The objective of the procedure is to obtain information to characterize the Natural Area, to paint a mental picture of the area through the use of words. It is not intended to generate data for any specific scientific purpose but rather to identify areas of potential importance as Natural Areas and to provide information for evaluation of possible compatible uses. In order that the information acquired for different Natural Areas be comparable for these evaluations it is important that application of the sampling methodology be standardized for different areas and sampling crews. The following methodology attempts to draw the guidelines for achieving this standardization. \frac{1}{2}

### Familiarization

Review all air photos, soil surveys, and topographic maps of the Natural Area to become familiar with the topography, soil moisture, location of water bodies and watercourses, and the contiguous land uses. Review all material in the Natural Area folder pertaining to the site.

### Preliminary Delineation

On the basis of this review make a preliminary determination as to whether the Natural Area delineations shown on the county map are appropriate. In some cases, overlapping areas drawn from separate sources were mapped as one area. You may find it desirable to subdivide large areas so as to facilitate description of the Natural Area, to more accurately describe distinct features, or to assign additional importance to a specific area. Similarly, it may be desirable to aggregate areas where the character of the laid is sufficiently similar and which are in close proximity to each other. In any cases where sites are divided or aggregated, follow the instructions for numbering the new areas contained under the tab "Card 1."

Tidal wetlands should be excluded from the Natural Area boundary as they are not under the scope of this study. Enclosed open water areas should be treated as part of the Natural Area.

### <u>Vegetation Type Delineation</u>

Using the soil survey and aerial photos, carefully elineate plant communities which appear different on the aerial photographs Soil types give an excellent indication of the vegetation one may encounter. These are subsections of the Natural Area. Generally, a subsection should not constitute less than 5% of the Natural Area or 10 acres, whichever is smaller. Exceptions should be made for small communities or features which are unusual or of special significance to the Natural Area. Enclosed open water portions of the Natural Area should not be designated as subsections unless they include significant floating or emergent vegetation.

### Field Sampling

Make a field reconnaissance of the different plant communities you have delineated. In the course of the survey adjust subsection boundaries to more accurately describe distinct vegetation communities or natural features. Add or combine subsections where appropriate. Sampling stations should be located, basal area and vegetation sampled, and resulting information recorded on a "Vegetation Sampling Form" for each subsection. Follow the instructions for sampling found under the tab titled Vegetation Sampling. During the course of the field sampling, record by subsection any species of mammals, birds, reptiles, or amphibians which are observed or heard or for which a nest or sign is found.

Where a Natural Area recorded on the site map cannot be found or it has been altered to the extent that it cannot be considered as a Natural Area, write "Not Found" or "Rejected" on the site folder and list the reason it has been excluded from the survey.

### Wetland Sampling

A Wetland Wildlife Rating should be completed for all Natural Areas which include one or more of the wetland classes listed under the "Wetlands" tab.

### Post Reconnaissance Review

Following the reconnaissance, review all Vegetation Sampling Forms making certain that all pertinent portions are completed. Complete the remaining data forms according to the following encoding instructions being careful that the recorded information accurately describes the site. Complete a "Card 7" form for each subsection. Subsections which have similar vegetational and physical characteristics may be grouped as "similar subsections." For each set of similar subsections, complete one "Card 7" form and a "Vegetation Sampling Form" for each component subsection.

For principally unvegetated areas such as historical sites, state champion trees on estates, etc., complete the pertinent parameters on all data forms except for "Card 7" and the "Vegetation Sampling Form."

Staple the completed data forms together in numerical order according to their card numbers. Group each set of Card 7 and Cards 8 by subsection. Do not include the "Audio-Visual Experience/Wetland Wildlife Rating" form in the stapled packet but include it in the folder.

### Air Photos

Record the numbers of all air photos on which the Natural Area is delineated in the space provided on the sampling forms. Check to be sure that all Natural Area boundaries and subsection boundaries are properly drawn on these photos. Label each Natural Area and subsection by number on each photo. Mark and number all locations where % cover vegetation samples were taken in each subsection. Upon completion, return the photos to the stack of county photos.

Where aerial photos are not available for the Natural Area, record the previous information on the soil survey photos and record the appropriate sheet numbers on the data form. Label roads and outstanding physical features on all photos used and indicate North with an arrow.

### Knowledgeable Persons

Be constantly alert for persons who may have knowledge about the natural features or history of Natural Areas. These may include hunters, fishermen, birders, school teachers and others. In conversation make it a point to collect names of others and set up appointments to interview the people on rainy days. Record the names of any such persons on the Names form for each Natural Area.

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The Study was organized in the following manner to carry out the sampling. Summer students were hired who had demonstrated experience in some type of vegetation analysis. These field crew members then participated in a one week training session to familiarize them with the sampling procedure and to achieve consistency between individuals. The crew was then divided into teams of two and each team was given the responsibility for sampling all the sites in a county. A field manager visited each team at regular intervals to help maintain the consistency of sampling techniques between teams, solve problems relating to the sampling procedure, and to distribute supplies.

# **CODING**

The nucleus of the study is the field evaluation and the data sheets which are generated for each Natural Area. These data sheets will be digitized on computer cards which will become the data bank for the study. Computer programs are being devised to permit the printing-out of selected combinations of data for easier handling and for comparison or ranking of areas.

As in any computerized data system, observed or ranked information will have to be translated into coding. This is a relatively easy process. A range of possible phenomena are listed in the encoding instructions with a specific number or symbol assigned to each. These numbers simply stand for the entire descriptive phrase or number associated with the actual field observation. Unlike typographical errors, where mistakes are readily observable, errors in encoding will be extremely difficult to detect. Therefore, it is essential that care be exercised in entering the code numbers into the appropriate spaces. The following sheets are instructions for filling out data forms by parameter. They are organized in the sequence which they occur on the data sheets. The transparent index dividers labeled - CARD #1, CARD #2....correspond to the computer card numbers on the data sheets.

An example of a completed set of data forms for a hypothetical site follows.

| -    | 2               |   |
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|   | OCCURRENCE  1. <u>Vortion</u> - Physical features or organism frequently encountered in the region. 2. <u>Infrequent</u> - Physical seatures or organism not commonly found are present; however, none are rare, endangered or unique.  3. <u>Mare</u> - Natural area confeaning an unusual physical feature or organism which is rare, endangered or at the geographic limit of its distribution.  4. Singularity Unique - Natural area containing a physical feature, organism or special habitat for an organism for the centar in the only known location in which it area is the only known location in which it area is the only   | AVERAGE WIDTH  1. Disjunct - Area is broken into segments 2. Less than 200 feet 3. 200-800 feet 4. 400-800 feet 5. 600-800 feet 6. 800-1020 feet 8. Greater than 1200 feet FODEST EDGE   |  |
|---|--|--|--|
| TOW CIREER WOODS    TOW CIREER WOODS  | SECURITY  1. Three-road with destruction within five years.  a. areas currently being disturbed by man  (i.e. charmalization, silation, logging, construction)  b. areas currently under plan to be altered  (i.e. sever lines, homes)  c. areas cortiguous with new development, highway intercanges  d. areas cortiguous with new development, highway  a. areas and commercial, residential, industrial  c. Areas safe for five years.  a. areas not currently threatened with destruction, but  not currently protected  3. Areas only endicitately.   | A. areas owned by conservation organizations, designated with the property of  | reated reased reated feated feated feated feated feated recessaring reated feated feat |
| Card * Area Number * Area Name * Area Name * 1 2 5 0 7 9 3 8 0 0 2 2 0 1 1 1 1 0 7   \$\frac{\pi}{2} \frac{1}{2} \f | GEOLOGY  OI. bgb, Beltimore Gabbro Complex II. Ql. Loviand Deposits  O2. 1g. James Run Gneiss  O3. Km, Negothy Formation  O4. Km, Negothy Formation  O5. Km, Negothy Formation  O5. Km, Noncouth Formation  O5. Km, Potnocuth Formation  O6. Kp, Potnocuth Formation  O6. Kp, Potnocuth Formation  O6. Kp, Potnocuth Formation  O6. Kp, Potnocuth Group  O7. The Anglory Formation  O8. Page, Curpowder Grante  O9. Page, Port Deposit oness  O9. Page, Port Deposit oness  O9. Page, Runternary Deposits  O wbg, Boulter Greise  O wbg, Boulter Greise | ter Individual  orational  oratio | CURRENT USE  Oi. Recreation O2. Vehicular Traffic (i.e. motor bikes) O3. Trails O4. Hunsing O5. Wilsilfe Management O6. There in Management O6. There in Management O7. Single Hone O8. Several Homes  11. Hone  |

| Contiguous Land Use (2) (2) (2) (2) (2) (2) (2) (2) (2) (2) | GUOUS LAND USE      | 1. High - Contains numerous different vegetation communities, animal habitats or physical features such as streams, bogs, contained 10. Highway 11. Railroad 12. Medium - Contains a few different vegetation types and contains predominantly one vegetation community contains predominantly one vegetation community containts or features.  12. Residential 13. Community contains predominantly one vegetation community one vegetat | Wildlife Management 16. | 1. Adequate - The Natural Area provides a band of natural or successional vegetation greater than 300 feet in vidth along more than 66% of the border of included or contiguous aquatic systems (werlands, watercourses, or waterbodies and adjacent D or Df soils).  2. Questionable - The Natural Area provides a band of natural or successional included or contiguous aquatic systems.  3. Incleding the contiguous aquatic systems.  3. Incleding to contiguous aquatic systems.  4. Not Applicable |
|---|---------------------|--|-------------------------|---|
| Card Contiguous #13 %   %   %   %   2   %   2   2   2   2   | CONTIGUOUS LAND USE | % of border by u 01. Natural Area 02. Wetland 03. Water Body 04. Park 05. Old Field 06. Managed Fore 07. Agriculture   |                         | AQUATIC BUFFER ZONE  1. Adequate - The Navegetation greate border of include or waterbodies an 2. Questionable - The vegetation greate included or contil 3. Inadequate - The vegetation less t of included or contil of included or contil Not Applicable  |

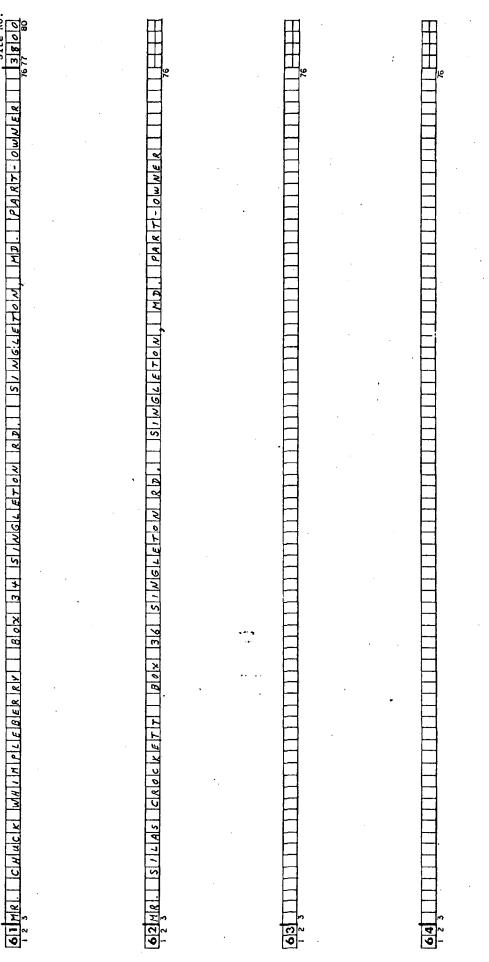
BORDERING SCENIC SINISLETON CREEK

Site No.

SATHIS SICE 1 NICLUPES 40 ACRES 0F HARDWOOD FOREST AND 20 ACRES DE FLOOD PLAIN 3800 5181810 RDERING ISINGLIETOW CAEER WEST OF ISINGLETON. WHITE DAKEDOMINATES IN TWE SINDASISABED APPENDENT. THUS FRODDED NO HAS AW WINDER STURBED APPENDANCE ISAVE TOOR AWD SDWALMUT OCCURING AS ASSOCIATES. DBH'S IM THIS PORTION OF THE WATERIC AREA SGARE ISPARISELY NEGETATED ALLLOWING EASY PAISAGE AND PROVIDIMG A "PARK"-LIKE" 5 L BLACK GUM AND RIVER BIRCH ALSO PRESENT. DBHIS OF THE CAMOPY TREES RAWGE SMERION 10 1-0 28 1 WCHESLINHE DEWISE SWRUB CAPER AND SCALIFERED WET AREAS HARE 51151ELECTIVE CUTITIONS MAY HAVE BEEN DONE IN THE DUSTANT PAST. THE FLOODPLAIN SHARPELARANCEL MO EURDEWCE OF MANMADE DUSTURBANCE US PARESENT MERE IALTHOLOM 51 FOREST LIES BETWEEN THE KIPLAMD PORTION OF THE SITE AND SINGLETON CREEK. 5: E/RANGE UP 170 36 120 26 28 WITH MANY WAITE OAKS OF 124 RESSIVE SINE SIED RESENT. SFSIMILLAR SPECIES ARE FOUND IN THE UNDERSTORY. THE SHRUB AND HERBILANERS 50 THAT CAUSED BY FLOOD! NO FROM SINNELETON CREEK! ON THE WHOLE THIS SITE SKSPCAMORE US THE PREDOMINANT SPECIES HERE WITH TKLIP POPLAR, REDIMAPLE 11/5/8/8/2 5 CUP & AWD SECTION WITH SL RED OAK, VIRBINIA PINE, CHESTNUT OAK

|          | TEXT P. 2  |
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|          | STEMAKES A VERK IMPRESSIVE WATURAL AREAL UNDISTURBED FORESTS OF THIS MATURITY 3 PO 0 |
|          | SOARE RARE IN THE REGION. THIS ISCENIC AREA BUFFERS SINGLETON CREEK FROM AD-         |
|          | SRJACIENTI AGRICULTIORAL LAND AND PROVIDES VALUABLE HABITAT FOR BOTH UPLAND AND      |
|          | 55 WETLAND WILDLIFE.   |
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NAME(S)



| Subsections Area (2) 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2   | 7 Type (3) 3 x x 1/8 1 2 3 0 3 3 0 3 3 5 0 2 2 3 6 7 2 6 1 6 3 2 3 3 3 3 3 5 0 2 2 3 6 7 2 6 1 6 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3  | 7 51 6 6 2 91 6 6 7 4 1 6 6 7 9 1 8 8 0 0  |
|--|---|--|
| AREA OF SUBSECTION(S) acres, including similar subsections   | WATERBODY BOTTOM MATERIAL  1. Peat - fibrous organic material with  | TOPOGRAPHY  1. Flat - little topographic relief over most of subsection  |
| WATERBODY DISTANCE 1. Same as this subsection 2. The lade of the constant of t | Muck<br>deco  | 2. Rolling - Hills with alopes 6.15% over most of subsection 3. Sicon - slopes > 15% over most of subsection 4. Mixed - flat or rolling topograph with significant areas (>33%) with steep alopes, gorges, or bluffs |
| 3. 10-200 feet 4. 50-100 feet 5. 100-200 feet 7. 300-500 feet 8. Creater than 500 feet   | 4. Since - granular schient with particles larger from 2 - granular schient with particles larger than 2 - granular schient with particles larger than 2 - 2 1/2-10 incles in dimerer.  7. Rock - solid aggregate of minerals larger than a cobble. | OF DISTURBANCE Channellzation 17. Dredging 18. Sever outlet 19. Culverse 19. Bulkheeding 20.   |
| WATERBODY TYPE   | BEACH TYPE  1. 31.7f - steep slope or abrupt embankment along   | Dikes Dams 73. Change in Watertable 24.  |
| 01. Primary Stream, < 5 feet wide 02. Secondary Stream, 5-30 feet wide 03. Tertary Stream, > 30 feet wide 04. Tital Stream 05. Sub-estuary 06. Potomac River 07. Glosopecke Bay  |   | 9. Logs and benis 25. Varialism 10. Beaver Dams 26. Tranpling 11. Algal Blooms 27. Motor Vehicles 13. Silteation 29. Other 14. Erosion 30. None 15. Roise 31. Plooding 16. Air Pollution 32. Graning                 |
|  | DEACH LENGTH  1. Less than 500 feet 2. 500-1000 feet 3. 100-500 feet  | w =  |
| MATERBODY SIZE   | BEACH WIETH  1. Less than 1 foot 4, Greater than 20 feet 2. 1-20 feet 5, Not Applicable 3 2.0-20 feet   | alteration of vegetation or natural feature 3. Low - man's impact evident but not significant b. None - evidence of man-made disturbance not present over most of the subsection                                     |
| 1. Less than 1 acre 2. 1-5 acres 3. 5-10 acres 4. 25-20 acres 5. 20-30 acres 6. Greater than 30 acres  |   | EASE OF PASSAGE  1. <u>Difficult</u> - Thick understory or wet mucky soil 2. <u>Modrate</u> - Interspersed understory or wet soils 3. <u>Dasy</u> - Open understory, dry soils                                       |
|  | -7-70   | ANIMALS  |
| WATERBODY DEPTH 1. Less than 1 foot 2. Greater than 1 foot   | SOIL DRAINAGE  1. Yes, well drained soils occur in the subsection 2. No, well drained soils do not occur in the subsection  | Notoord 4 letter code and source for each animal. Source 1. Observed or Heard 2. Reported  |

|            | \        |          | 7      | 7  | S POU         | 188//                |         |         |           | Z         | GETA                                      | NOL             | VECETATION SAMPLING FORM | FE        | 5        | Z                 |      |      | ;        |   |          |                     |   |                      | •               |               |
|------------|----------|----------|--------|--|---------------|----------------------|---------|---------|-----------|-----------|---|-----------------|--------------------------|-----------|----------|-------------------|------|------|----------|---|----------|---------------------|---|----------------------|-----------------|---------------|
|            | Site     | Site No. | 7      | Sect/  | 30            | Total Co Se Se Tally |         |         |           |           |   |                 |                          |           |          |                   |      |      |          |   |          |                     |   |                      |                 | ,             |
| <b>~</b> ~ | 3 8      | 00       | 0      | 118  |               | 2 8                  |         |         | •         |           |   | ,               |                          | •         |          |                   | ų    |      | ,        | ٥   | _        | đ                   |   | c                    | •               |               |
|            |          |          |        | 17   | 13            |                      | F       | Tolly " | THE P     | m m/      | 1   | M M             |                          | . M       | 1111 200 | \                 | M 14 | m m  | - 3      | J. M. 1111                                |          | H 18                |   | ,                    | IAYER           |               |
|            | ,,       | Species  | •      | 20 0/0<br>0 0 0<br>0 0 0 0<br>0 0 0 0<br>0 | 460<br>102 0% | selvens.             |         | % Cov.  | (Sep      | Cet/%Cov. | %<br>************************************ | 1000 (co. /co.) | %Co.                     | You you   | , Se.    | 10%<br>10%<br>10% |      | Cov. | %/sø     | 10,00 /00 /0,00 /00 /0,00 /00 /0,00 /00 / | ڻ<br>پير | ×. (88)             |   | \<br>\(\rightarrow\) | 1. can          | , ddc         |
| 2          | *        | 9        | 7 /    | 1  |               | White                |         | *       | 7         | T         |   |                 | 3                        | 16        | H        | Ц                 |      | #    | 8        |   |          |                     |   |                      | 2. unde         | 2. understory |
| 28         | 7        | 6        | 5 /    | 7  | 2 7           | S. Rod Oak           |         | 7       | 4         |           |   |                 | 2                        | 0         |          |                   |      | `,   |          |   |          |                     |   | Т                    | 4. her          |               |
| 33         | 4        | 7 4 6    | 1/3    |  | 9 7           | Va. Pine             |         | `       | 5         |           | _   |                 | 0                        |           |          |                   |      | 7    | 6        | -   |          | 寸                   |   | 7                    |                 |               |
| 4          |          | 2 4      | ,      | 7  | 0 5           |                      |         | 0       | 5         |           |   |                 | 0                        | ک         |          |                   |      | 1    | _        | -   |          |                     | _ | _                    | IMPORT          |               |
| 6          | 3        | 3        | 3 /    | 9  | 9 0           | Black Walout         |         |         |           |           |   |                 | 0                        | 9         |          |                   |      | 1    | -        |   |          |                     |   | _                    | . 1. uni        | que or rare   |
| 57         | 5        | 0        | 7 7    | )  | 0 5           | Chestout Oak         |         |         |           |           |   |                 |                          |           | $\dashv$ |                   |      | 0    | <b>ل</b> | _   |          |                     |   | -1                   | 2. end          | 2. endangered |
| 9          | <i>'</i> | 9 6      | 19     | 7  | 40            | Hackberry            | **      | 0       | 4         |           |   | _               | ١                        |           |          |                   | -    | ١    | -        |   |          |                     |   | _                    |                 |               |
| 73         |          |          | 7      |  |               | Red Maste            |         | *       |           | <u> </u>  |   |                 | 3                        | <u> </u>  |          |                   |      | 7    |          |   |          |                     |   |                      | AVEDACE         | AVEDACE       |
| 8 2        |          | ++       | ++     |  | (9-15         | 100                  |         |         |           |           |   |                 |                          |           |          |                   |      |      |          |   |          |                     |   | 1 i                  | % COVER         | DBH           |
| Li         | 7        | 6        | 7 7    | ,,4  | 7             | White Oak            |         | 2       |           |           |   |                 | 3                        |           |          |                   |      | 7    |          | $\dashv$                                  |          |                     |   |                      | ,<br>,          | "( L-1        |
| 52         |          | 8        | 7 7    | Ľ  | . 0           |                      |         | ,       |           |           |   |                 | 0                        |           |          |                   |      | o    |          |   |          | ·                   |   |                      | 1-10            | 2=4-6"        |
| B          | -        | _        | 7 7    |  | 0             | ہ ا                  |         |         |           |           |   |                 | 0                        | _         |          |                   |      | ı    |          |   |          |                     |   |                      | 2-20            | 3=6-9"        |
| ₹          | *        | 6        | 5      | ٥  | 0             | S. Red Oak           |         | 0       |           | -         |   |                 | -                        |           |          |                   |      | 0    |          | $\Box$                                    |          |                     |   |                      | 3-30            | 4=9-12"       |
| 69         | 5        | 0        | \<br>8 | 3  | 0             | N. Red Oak           |         |         |           |           |   |                 |                          | _         |          |                   |      | 0    | لئ       |   |          |                     |   |                      | 5-50            | 6=18-24"      |
| 57         |          | 3.       | 2 3    |  | 0             | and                  | γ.      | 0       |           |           |   |                 | 0                        |           |          | _                 |      | 1    | _        |   |          |                     |   | -                    | 6-60            | 7=24-30"      |
| 65         | 9        | 8        | 2 3    |  |               | H. B. Blueberry      |         | 7       |           |           |   |                 | 7                        |           |          |                   |      |      | $\dashv$ | -   |          |                     | • |                      | 7-70            | 8=30-36"      |
| 73         | 7        | 9        | 7 3    |  |               | Panale becey         |         | 0       |           |           | _   | $\exists$       |                          | _         | $\dashv$ | _                 | _    | 7    | -        | $\exists$                                 |          |                     | - |                      | 00-0            | 054 =         |
| 88         |          | #        | +      | Ĭ  | (9-16         | m                    |         |         |           |           |   |                 |                          |           |          |                   | . [  | Ì    |          |   |          |                     |   | 1                    |                 |               |
| 17         | 9        | 191      | 1 3    |  |               | Maple Lud. V         | Viburna | 0       |           |           | _   | 4               | _                        | $\exists$ | $\dashv$ |                   |      | 7    |          | $\dashv$                                  |          |                     | 1 | ₹<br>                | ANIMALS:        |               |
| 25         | 12       | 176      | 6 3    |  | 0             | Haze                 |         |         |           |           | 4   |                 | 0                        |           | -        | _                 | _    | 7    | $\dashv$ | $\dashv$                                  |          | $\exists$           | 1 | _                    | Gray Squire     | of nest       |
| 33         | 29       | 3        | 7 4    | 7  | 0             | Solomons Soul        |         |         |           | -         | _   | -               | 7                        |           | -        |                   |      | 0    | 4        | 1   |          |                     | 7 | 7                    | Br. Crosper     |               |
| ₹          | 2 7      | 4        | 5 4    | Ĭ  | 0             | Rome Pipes           |         | 9       |           |           | 4   | -               | 0                        |           |          | ,                 |      | 1    | -        | -   |          |                     |   | 1                    | Gr. Sorned      | 1-0           |
| 49         | 2 9      | 7        | 5 4    |  |               | Hay Apple            |         |         |           |           | _   | $\exists$       | 0                        |           | -        |                   |      | 7    | -        | $\dashv$                                  |          | _                   | 7 | <del></del> -        | Solitary Vires  | ندوه          |
| 57         |          | 8        | 4 4    |  | 0             | Parteidos Berry      | 7.7     | 0       |           |           | _   | $\exists$       | 0                        | $\exists$ | $\dashv$ |                   | -    | 0    | $\dashv$ | $\dashv$                                  |          | $\rightrightarrows$ | 1 | _                    | Over Bird       |               |
| 69         | 2 2      | 9        | 4 6    |  | 0             | 1                    |         | 0       |           |           |   | -               | ١                        | _         | -        |                   |      | 1    | $\dashv$ | 4   |          | 1                   | 1 |                      | Scarlet Tanager | ,             |
| ĸ          | 2 /      | ) E      | 4 1    |  | 7             | - 74                 |         | 4       | $\exists$ | $\dashv$  | 4   | $\exists$       | -                        | $\dashv$  | $\dashv$ | _                 |      | 7    | 4        | 7   |          | $\exists$           | 7 | _                    | Doury Wo        | odpecker      |
| ٠          |          |          |        | ŧ  |               |                      |         |         |           |           |   |                 |                          |           |          |                   |      |      |          |   |          |                     |   |                      |                 |               |

NOTES: Large Trees Easy Passage

| 3391/62631/64021/1   Site No. 3391/6200   | TOPOGRAPHY  1. Figt - little topographic relief over most of subsection 2. Holling - hills with slopes < 15% over most of subsection 3. Steep - slopes - 15% over most of subsection 4. Mixed - flat or rolling topography with significant areas (>33\$) with steep slopes, gorges, or bluffs | OF DISTURBANCE Channelization 17. Dredging 18. Sever Outlet 19. Culverts 20.   | 0. Dixes 7. Dans 8. Change in Watertable 24. Littering, paper 9. Logs and Debris 25. Vandalism 10. Beaver Dans 26. Trampling 11. Alga Blooms 26. Trampling 12. Fedid Odor 29. Other 13. Siltation 29. Other 14. Evesion 30. None 15. Noise 16. Air Pollution 32. Grazing | DEGREE OF DISTURBANCE  1. Severe — man's impact resulting in severe alteration of vegetation or natural feature 2. Moderate — man's impact resulting in moderate alteration of vegetation or natural feature 3. Low — man's impact evident but not significant b. Money — evidence of man-made disturbance not present over most of the subsection | EASE OF PASSAGE  1. <u>Difficult</u> - Thick understory or wet mucky soil 2. <u>Moderate</u> - Interspersed understory or wet soils 3. <u>East</u> - Open understory, dry soils | ANIMALS  Record 4 letter code and source for each animal.  Source 1. Observed or Heard 2. Reported 3. Den, West or Spoor'  |
|---|--|--|--|--|---|--|
| Soil (\$\frac{\partial}{\partial} \\ \partial \qual \qu | WATERBODY BOTTOM MATERIAL  1. Peec - fibrous organic material with recognisable plant purts.  2. Mack - black core composed of silt and decomposed organic material.  3. silt - fine sediment with little organic material.  | <ul> <li>b. Sand - granular sediment.</li> <li>c. orecol - granular sediment with particles larger than 2m (peproximately 1/8 in.).</li> <li>c. obble - round or sub-round, water-worn rock 2 1/2-10 incles in diameter.</li> <li>r. Rock - solid aggregate of minerals larger than a cobble.</li> </ul> |  | BEACH LENGTH  1. Less than 500 feet 2. 500-1000 feet 3. 1000-1500 feet BEACH WIDTH  1. Less than 1 foot 2. 1-10 feet 5. Not Applicable 5. Not Applicable   | 3. 10-20 fee:  % OF STREAM SHADED 0. Less than 10% 4. 17-100% 2. 25-50% 5. Not applicable   | SOIL DRAINAGE  1. Yes, vell drained soils occur in the subsection 2. No, well drained soils do not occur in the subsection |
| Card Similar Area (2) (2) (2) (2) (2) (2) (3) (3) (3) (3) (3) (3) (3) (3) (3) (3  | AREA OF SUBSECTION(S) acres, including similar subsections WATERBODY DISTANCE 1. Same as this subsection   | 2. Included or contiguous (1-10 feet) 3. 10-50 feet 4. 50-100 feet 5. 100-200 feet 6. 200-300 feet 7. 300-500 feet 8. Greater than 500 feet  | WATERBODY TYPE  O1. Primary Stream, <5 feet vide  O2. Secondary Stream, > 30 feet vide  O3. Tertiary Stream, > 30 feet vide  O4. Tidal Stream, > 30 feet vide  O5. Sub-estuary  O6. Procaman River  O7. Chesapeake Bay   | WATERBODY SIZE   | 1. Less than lacre 2. 1-5 acres 3. 5-10 acres 4. 10-20 acres 5. 20-30 acres 6. Greater than 30 acres 7. Not applicable  | WATERBODY DEPTH  1. Less than 1 foot 2. Creater than 1 foot  |

1=1-4" 2=4-6" 3=6-9" 4=9-12" 5=12-18" 6=18-24" 7=24-30" 8=30-36" 9= >36" 1. unique or rare 2. endangered AVERAGE DBH 1. canopy
2. understory
3. shrub
4. herb Red. Shoulder Y.B. Sapsucki Green Heron IMPORT AVERAGE % COVER 0-45 1-10 1-10 3-30 1-10 5-50 6-60 6-60 9-90 Spotted ANIMALS: Cros % cor. / (2) / 6,6 cor. / (2) / 6,6 cor. / (2) / 6,6 cor. / (3) / 6,0 cor. / (3) 111 MT/ pr un/ VEGETATION SAMPLING FORM m m %cox/63/%cox./63 I'm mi ч 0 0 3 / JM 1111 6, con 4 3/9, con 100 100 con 100 2 IM M1 ſ ч 0 4 0 Stunk Cabbage Sweet Gum Possom. Haw Leucothoe Red Haple Tulip Poplar Gree. Ash Black Gun River Bicch Commen Account (9-16 Blank) (9-16 Blank) 8113800027 0 5 9 5 3 6063 4 0 0 7 3313 763 Species 3 3 3 4 9 5 7 7 5 9 3 0 9 4 4 4 9 400 0 1 5 3 \* 3 4 41 3 33 49 2. 73 8 2 8 3 3 25 33 4 6 57 65 <u>` 17</u> 23 17 57

NOTES: Fliding

-22\_

# AUDITORY AND VISUAL EXPERIENCE

Indicate The Experience Characteristics of The Entire Area. Circle the appropriate word on the data sheet for each evaluation. Where indicated, enter the code in the blank preceding selected evaluations. Add the numerical codes for a Total Score.

# Auditory

Noise from offsite Nature of offsite noise

little/none infrequent

# intermittent constant audible

loud

long panoramas large Typical length of views Typical nature of views Scale of landscape elements

mixed enclosed

Intermediate short (mixed)

small mixed

little  $\frac{1}{\sin 311}$ 2 moderate moderate

> 3 large great

CODE:

Variety (diversity) of

Size of site

visual elements Views of water

rare/none

occasional

frequent

rapid

Rate of landscape

W

slow

unnoteworthy intermediate simple moderate pleasant complex impressive

change over distance Complexity of topography Personal impression

| 4 | Experience Total Score (enter in boxes)

Experience Term (enter in box) 3

37

1. low 2. medium

3. high

# WETLAND WILDLIFE RATING

| 5x /. 5 = 7.5  | 5x 2.0 10      | 5x 1,5 7.5 | 4x 3.0 = 12 | 3x 1.5 = 4.5 | 4x 30 - 12     |                                   |                             | -                        | 3x 1.0 = 3.0 | 0 7 = 0 8 %     | Total 62.5 |
|----------------|----------------|------------|-------------|--------------|----------------|-----------------------------------|-----------------------------|--------------------------|--------------|-----------------|------------|
| Class Richness | Dominant Class | Size       | Site Type   | Cover Type   | - <del> </del> | Salt Marsh Mining, Waste Disposal | Urban<br>Outdoor Recreation | Vegetative Interspersion | 3 4          | Juxtaposition . | 63         |
|                |                |            |             | ^            |                |                                   |                             |                          |              |                 |            |

Visual

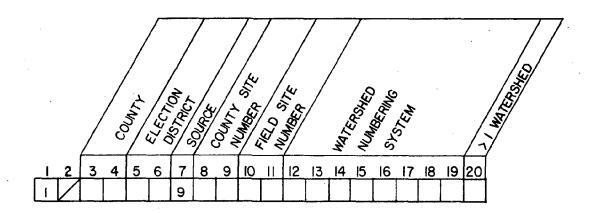
# **ENCODING INSTRUCTIONS**

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# AREA NUMBER

Card 1, spaces 3-20.

Natural Area Numbers are recorded on the county scale site maps and on the folders which correspond to each site. Record this number on the data form. Where the number is incomplete or a new site is designated, assign numbers according to the following directions.



### County Numbers

Indicate the County which contains the major portion of the Natural Area.

02. Anne Arundel

08. Cecil

03. Baltimore

09. Charles

04. Baltimore City

13. Harford

05. Calvert

17. Prince Georges

19. St. Mary's

### Election District

Indicate the Election District which contains the major portion of the Natural Area. This information is available on the County Topographic Maps.

### Source

We are considered by State Planning's MAGI computer system to be information source #9.

### Site Number - County Site and Field Site

Sites have been delineated and numbered on each County Site Map. Record the number indicated on the map or folder.

Natural Areas are given a 4-digit number. The first two digits refer to the County Site Number. The second two digits refer to the Field Site Number. County sites are numbered sequentially within the county. Field sites are numbered sequentially within a county site. County sites are separate Natural Areas within a county. Field sites designate contiguous Natural Areas within a county site which, for the purposes of this study, are described as discrete Natural Areas.

Where a new Natural Area is designated within a county, assign it a new county site number as the next number in the sequence of county sites. Where a site designated as one Natural Area is determined to be two or more Natural Areas, assign them Field Site Numbers as the next numbers in the sequence of field sites with the County Site Number remaining unchanged. Where two or more sites designated as separate county or field sites are determined to be one Natural Area, combine them under one County Site Number and assign the composite the next Field Site Number in the sequence of field sites.

### Watershed Number

Each watershed and sub-watershed has been numbered by the Maryland Department of Natural Resources Water Resources Administration. See the attached list and record the watershed number for each Natural Area.

#### More Than One Watershed

Where a site occurs in more than one watershed, mark an asterisk (\*) in space 20.

# AREA NAME

Card 1, spaces 21-57.

### Sites Already Named

Where a site already has a name it should be recorded as given on the file folder or in secondary sources of information.

### Sites Without Names

Sites with no names should be given a name which reflects the salient characteristics of the site. Where a site is assigned a name in the field it should be indicated as such with an asterisk before the name. Leave a space between words.

### For example:

- 1. \*MIXED FOREST WITH RHODODENDRONS
- 2. \*WICOMICO CREEK FRESHWATER MARSH
- 3. \*TALBOT SCARP
- 4. \*PLAINFIELD NATURAL SPRINGS
- 5. \*NATURAL UNDISTURBED LOBLOLLY PINE STAND
- 6. \*REGENERATING BALD CYPRESS FOREST
- 7. \*NORTHERN LIMIT OVERCUP OAK STAND
- 8. \*ELK NECK CLIFFS

# DATE

Card 1, 58-63.

Indicate the month, day, and year on which the Natural Area was field checked.

### Month

- 05. May
- 06. June
- 07. July 08. August
- 09. September
- 10. October

# **NEAREST**

Card 1, spaces 64-80.

Using a county scale map as a source, find the town nearest to the Natural Area by straight line distance. Print the name in the spaces provided, using abbreviations when necessary.

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### **ELEVATION**

Card 2, spaces 3-6.

Using the county topographic maps, indicate the elevation of the Natural Area in feet. Where one contour interval crosses the site, record its number as the elevation. Where more than one interval crosses the site or the site falls between contour intervals, record the average as the elevation.

Right justify the elevation, leaving blanks before the numbers.

### **GEOLOGY**

Card 2, spaces 7-9.

Indicate the predominant geological formation which underlies the Natural Area using the Geologic Map of Maryland, 1968. Record the code number in the first two spaces. If more than one formation underlies the area, place an asterisk (\*) in the third space.

- O1. bgb, Baltimore Gabbro Complex
- 02. jb, James Run Gneiss
- 03. Km, Magothy Formation
- 04. Kma, Matawan Formation
- 05. Kmo, Monmouth Formation
- 06. Kp, Potomac Group
- 07. pCbg, Baltimore Gneiss
- 08. Pzgg, Gunpowder Granite
- 09. Pzpd, Port Deposit Gneiss
- 10. Qdu, Quaternary Deposits
- 11. Q1, Lowland Deposits
- 12. Qtu, Qu, Upland Deposits
- 12. Qua, qu, optana bepostor
- 13. Sf, Setters Formation
- 14. Ta, Aquia Formation
- 15. Tc, Calvert Formation
- 16. Tch, Choptank Formation
- 17. Tn, Nanjemoy Formation
- 18. Ts, St. Mary's Formation
- 19. Vc, Volcanic Complex
- 20. wbg, Boulder Gneiss
- \*. more than one formation

## **OWNERSHIP**

Card 2, spaces 10 and 11.

Indicate who is the principal owner by recording the appropriate code in the left space. If the area is owned by more than one party, indicate by placing an asterisk (\*) in the second space on the right.

#### Ownership

- 1. Private Individual
- 2. Corporation
- 3. Educational Institution
- 4. Private or Non-Profit Public Organization
- 5. Local Government
- 6. State Government
- 7. Federal Government
- 8. Unknown
- \*. More than one owner

### **BIBLIOGRAPHY**

Card 2, spaces 12-29.

Indicate the identification number of any bibliographic citations which relate to the Natural Area. Spaces are provided for citing 6 references. This information is initially available on the site file folder for the following references. Encode the numbers which pertain to the source initials found on the outside of the folder.

#### Bibliography

034 - Brush 216 - CNAM 207 - CT 124 - HA 204 - JA 206 - JAE 280 - PA 302 - PLOM 310 - SM 308 - SMPA 314 - SNAACP 220 - SP

120 - WA 252 - WE

If you become aware of other studies not listed in the folder with information pertaining to the Natural Area, record the citation as shown in the enclosed sample and give it a discrete number according to the county as follows:

#### County

401-430 Anne Arundel 431-460 Baltimore 461-490 Baltimore City 491-520 Calvert 521-550 Cecil 551-580 Charles 581-610 Harford 611-640 Prince Georges 641-670 St. Mary's

INTERNATIONAL BUSINESS MACHINES CORPORATION

Bibliography Master Sheet

Sample:

IBX

Leave

80-COLUMN CARD PUNCH LAYOUT

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 23 24 23 24 27 28 29 30 31 32 33 39 40 41 42 48 49 50 51 50 53 54 55 56 57 58 59 50 51 62 58 60 51 62 63 64 63 64 63 64 65 65 67 70 71 72 73 74 75 78 79 78 79 (Limit) spaces IOWS Ŋ separate and after) ExCURS MARYLAND SPECTE ı (Title before Title SHOR C Z E NC E S 0 (Article Q EASTER Title) (Publication Date) 32500 Last Name First) 19612 (Publication OTANICAL RE PROCD Author, Pus 0 P K I W S and publisher) 8 (Place (Article) J011 (Book) 29 A ANT 40NY 729BEASTERN 80388ALT s refe**r**ence) 8039861 consecutively for 1 & 2 Blank other references) do not duplicate for (Identification Mumber

### SITE SOURCES

The areas selected as candidates for field investigation were chosen and mapped from the following sources. The initials, preceding each reference are those which are recorded on the site folders to indicate site source and to reference background information.

- Brush Brush, Grace and M. Katherine Poese, 1975 and 1976. Personal Communications. Following a field study of sampling and mapping forest vegetation in Maryland, these areas were nominated for study as potential Natural Areas. Usually, these are mapped as general areas which require further refinement in the field.
- CNAM . 1968. Catalog of Natural Areas in Maryland. Maryland State Planning Department. The purpose of this document was to briefly present some basic information on certain Natural Areas within the state of Maryland. Areas having unique historical, geological, or ecological value or a combination of such values were represented in this catalog. "Whenever possible the areas selected had to be in a natural state or near natural condition and not show evidence of recent disturbances that would impair their value." These areas were not field checked.
- CT Maryland Department of Natural Resources, Maryland Forest Service. 1976. State Champion Trees. Personal Communication.
- HA Harris, Herbert S. Jr. 1976. The Natural History Society of Md., Inc. Personal Communication. Known locations of endangered reptiles and amphibians in Maryland.
- JA Jackson, William. 1973. Chesapeake Bay: Inventory of Potential Shoreline Access, Recreation and Open Space Areas. Part I: The West Shore. Maryland Department of Natural Resources, Program Planning and Evaluation section. (Unpublished)

  This study was undertaken in the summer of 1972 to identify

This study was undertaken in the summer of 1972 to identify areas with the potential to provide public recreation, open space, or water access. Sites described and mapped by this study are included for study as potential Natural Areas.

JAE - Jackson, William. 1973. Chesapeake Bay: Inventory of Potential Shoreline Access, Recreation and Open Space Areas. Part II: The East Shore. Maryland Department of Natural Resources, Program Planning and Evaluation section. (Unpublished)

Companion volume to Part I: The West Shore. Areas in Cecil

County are included in this volume.

NA - U.S. Navy, Planning Division, Chesapeake Division. 1975. Personal Communication. Navy bases with significant forested areas to be checked for Natural Areas.

- PA Public lands taken from areas mapped in green on the county topo maps and areas proposed for acquisition by Department of Natural Résources, Land Planning Services.
- PLOM Shreve, Forrest. 1910. The Plant Life of Maryland. Maryland Weather Service, Johns Hopkins Press. This volume describes the distribution of plant life in Maryland. Potential Natural Areas mentioned in this were chosen for study in the field survey.
- SM . 1974. <u>Natural Areas of the Chesapeake Bay</u>

  <u>Region: Ecological Priorities.</u> Center for Natural Areas, Ecology

  <u>Program, Smithsonian Institution.</u>

The purpose of the study was to recommend for procurement those Natural Areas which Smithsonian personnel judged to be of highest priority for preservation. This survey made use of information already available. Preliminary field checks were made on 30 percent of the designated areas.

- SMPA Smithsonian Center for Natural Areas, 1973. "Areas Currently Protected" mapped on 1:250,000 scale Chesapeake Bay Region map. Conservation areas other than military sites were taken from this map.
- SNAACP . 1974. Survey of Natural Areas of the Atlantic

  Coastal Plain. Center for Natural Areas, Office of International and Environmental Programs, Smithsonian Institution.

  This survey mapped and described selected Natural Areas on the coastal plain between Georgia and Massachusetts. Sites were mapped on quad scale maps for use by the National Park Service.
- 1975. Compendium of Natural Features Information.

  Maryland Department of State Planning.

  This compendium serves as an update of the Catalog of Natural

  Areas in Maryland. The Natural Areas were briefly described and mapped at a scale of 1:63,360. These sites were not field checked.
- WA Abbott, Jack. 1976. 1976 <u>Eagle Nest Survey</u>. Cooperative project with Maryland Wildlife Administration. (Unpublished)

  Bald eagle nest sites field checked yearly.
- WE . 1968. State Wetlands Inventory. Cooperative project,
  Department of Game and Inland Fish, Department of State Planning.
  (Unpublished)

Most of these wetlands were not field checked and any information concerning them should be considered unverified.

### **CURRENT USE**

Card 2, spaces 30 and 31. Indicate the current major use of the Natural Area.

#### Current Use

- Ol. Recreation
- 02. Vehicular Traffic (i.e. motor bikes)
- 03. Trails
- 04. Hunting
- 05. Wildlife Management
- 06. Timber Management
- 07. Single Home
- 08. Several Homes
- 09. Swimming
- 10. Fishing
- 11. Boating
- 12. Pasture
- 13. Agriculture
- 14. Woodlots
- 15. Dumping
- 16. Other
- 17. None

### **SECURITY**

Card 2, space 32.

Indicate the probable time frame within which significant physical alterations by man's activities may occur. Assess all facets of an area which may contribute toward the encroachment or destruction of the Natural Area.

#### Security

- 1. Threatened with destruction within five years.
  - a. areas currently being disturbed by man
    - (i.e. channelization, siltation, logging, construction)
  - b. areas currently under plan to be altered
    - (i.e. sewer lines, homes)
  - c. areas contiguous with new development, highway interchanges
  - d. areas zoned commercial, residential, industrial
- 2. Areas safe for five years.
  - a. areas not currently threatened with destruction, but not currently protected '
- 3. Areas safe indefinitely.
  - a. areas owned by conservation organizations, designated as wildlife management areas or parks.
- 4. Unknown.

## **ACCESS**

Card 2, space 33.

Indicate the ease of approach to the Natural Area.

#### Access

- 1. Easy Major highway or road to site
- 2. Moderate Trail to site
- 3. Difficult Isolated area, no road or trail to the site

# SITE TYPE

Card 2, space 34.

The Site Type refers to the general or dominant characteristic of the Natural Area. It attempts to answer the question "Why was this site designated as a Natural Area?" Where more than one type occurs within an area, list that type which is of greater significance to the Natural Area or is of greater regional significance.

"Cultural site" should be used to indicate a site of historical or archeological importance.

"Champion Tree" should be used to indicate sites with a designated or potential "National" or "State Champion Tree."

#### Site Type

- 1. Water Body
- 2. Upland Deciduous Forest
- 3. Lowland Deciduous Forest
- 4. Upland Evergreen Forest
- 5. Lowland Evergreen Forest
- 6. Upland Mixed Forest
  - 7. Lowland Mixed Forest
  - 8. Cultural Site
  - 9. Champion Tree

## INTEGRITY

Card 2, space 35.

Indicate the present "Natural Integrity" of the area on the basis of natural regeneration, age, and the absence of disturbance.

#### Integrity

- 1. Naturally Permanent Vegetation or physical feature is relatively stable as revealed by the pattern of regeneration or the absence of physical deterioration. Disturbance is insignificant although some natural disturbance may be in evidence. Vegetation is mature or relatively stable because of its ability to resist succession.
- 2. <u>Naturally Transitory</u> Vegetation or physical feature is changing due to plant succession either as a consequence of man-made or natural disturbance such as fire, erosion or flooding. Vegetation is relatively young and dynamic.
- 3. <u>In Need of Management</u> Area will require management to maintain present character.
- 4. <u>Uncertain</u> Possible source of change is not evident.

### **OCCURRENCE**

Card 2, space 36.

Indicate the relative frequency of the Natural Area in the context of its occurrence on the Western Shore Coastal Plain. Where an unusual feature occurs within the area or where the Natural Area provides the habitat for a particular plant or animal which is in some way rare, unique, or unusual, then "Occurrence" shall be defined in terms of this feature, plant, or anima.

#### Occurrence

- 1. <u>Common</u> Physical features or organism frequently encountered in the region.
- 2. <u>Infrequent</u> Physical features or organism not commonly found are present; however, none are rare, endangered or unique.
- 3. Rare Natural area containing an unusual physical feature or organism which is rare, endangered or at the geographic limit of its distribution.
- 4. Singularly Unique Natural area containing a physical feature, organism or special habitat for an organism for which the area is the only known location in which it occurs.

### SIZE

Card 2, spaces 37-40.

Record the size of the Natural Area in acres. Include all areas designated as subsections so that the total acreage of the subsections equals that recorded for the site. Right justify the area, leaving blanks before the numbers.

Use the dot grid to determine the number of acres on the aerial photographs. A dot grid (provided in the notebook) is a transparent overlay with dots systematically arranged on a grid pattern. In use, the grid is aligned with a straight line feature to avoid positioning bias and then dots or squares are tallied for the area. Follow the instructions on the transparent overlay.

#### Photo Scale

no. dots counted x 2.5 acres/dot = no. acres

## **AVERAGE WIDTH**

Card 2, space 41.

Indicate the "Average Width" of the Natural Areas measured on the aerial photographs.

#### Average Width

- 1. Disjunct Area is broken into segments
- 2. Less than 200 feet
- 3. 200-400 feet
- 4. 400-600 feet
- 5. 600-800 feet
- 6. 800-1000 feet
- 7. 1000-1200 feet
- 8. Greater 1200 feet

#### Photo Scale

### FOREST EDGE

Card 2, space 42.

Using the aerial photographs as a source, indicate the relative length of forest/opening edge which occurs along the forested portions of the Natural Area.

#### Forest Edge

- 1. <u>Minimal</u> Forested portions of the site occurring essentially as a single block with a minimum of forest/opening edge.
- 2. <u>Moderate</u> Forested portions of the site somewhat dissected or occurring as a single block with internal openings resulting in a moderate amount of forest/opening edge.
- 3. <u>High</u> Forested portions of the site highly dissected, occurring in narrow strips and/or including numerous enclosed openings resulting in a substantial amount of forest/opening edge.
- 4. Not applicable No forested subsections.

The interface between forest and opening contributes to the value of an area as wildlife habitat as well as enhances its scenic qualities. For the purpose of this parameter, "opening" is defined as an open water or vegetated area with less than ten percent cover of canopy or understory trees contiguous with or enclosed by forest. "Forest" pertains to the portions of the site described as subsections with vegetation types numbered 1 through 104.

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# CONTIGUOUS LAND USE

Card 3, spaces 3-18.

Four sets of four spaces are provided for indicating the 4 major Contiguous Land Uses and the percent of the Natural Area's border on which each use occurs. In the first two spaces of each set indicate the percent of border and in the second pair of spaces encode the land use. The total of the four percentages need not equal one hundred percent. Where land use 01, "Natural Area" is encoded, this adjacent area must be described as a separate site.

#### Contiguous Land Use

- 01. Natural Area
- 02. Wetland
- 03. Water Body
- 04. Park
- 05. Old Field
- 06. Managed Forest
- 07. Agriculture
- 08. Wildlife Management
- 09. Road
- 10. Highway
- 11. Railroad
- 12. Residential
- 13. Commercial
- 14. Industrial
- 15. Recreational
- 16. Town
- 17. Channelized Stream
- 18. Right of Way
- 19. Dredge Spoil Disposal

## AQUATIC BUFFER ZONE

Card 3, space 19.

Aquatic buffer zones are important in protecting aquatic systems from erosion and from contamination by non-point source pollutants such as sediment, fertilizer, and pesticides. A detailed description of the various aspects of the aquatic buffer zone concept is included in the field notebook.

For the purposes of this study, a buffer zone is a band of vegetation contiguous with an aquatic system. An aquatic system is defined as a wetland, watercourse, or water body, and adjacent soils with D or D<sup>+</sup> runoff potential. D and D<sup>+</sup> soils are included in aquatic systems because they contribute significant overland runoff to storm flow. A list of D and D<sup>+</sup> soils by county is included in the field notebook.

The value a Natural Area has as an aquatic buffer depends on the width and length of vegetation that it provides along its border with aquatic systems. These aquatic systems may be included or contiguous: part of, enclosed by, or adjacent to the Natural Area.

Indicate the width of vegetation within the Natural Area which occurs along more than 66% of the vegetation/aquatic system edge. Encode the lowest numbered category which fits the Natural Area.

#### Aquatic Buffer Zone

- Adequate the Natural Area provides a band of natural or successional vegetation greater than 300 feet in width along more than 66% of the border of included or contiguous aquatic systems (wetlands, watercourses, or waterbodies and adjacent D or D<sup>+</sup> soils).
- 2. Questionable the Natural Area provides a band of natural or successional vegetation greater than 50 feet in width along more than 66% of the border of included or contiguous aquatic systems.
- 3. <u>Inadequate</u> the Natural Area provides a band of natural or successional vegetation less than 50 feet in width along more than 66% of the border of included or contiguous aquatic systems.
- 4. Not Applicable

#### Photo Scale

| 1:20,000                                    | 1 inch = 1,667 feet<br>0.18 inches = 300 feet         |
|---|---|
| 1:31,680 (Cecil County)                     | <pre>1 inch = 2,640 feet 0.11 inches = 300 feet</pre> |
| 1:15,840<br>(Xerox Photos,<br>Cecil County) | <pre>1 inch = 1,320 feet 0.22 inches = 300 feet</pre> |

With D, D+ Soils QUESTIONABLE INADEQUATE ADEQUATE \_ Natural Area Example: Aquatic Buffer Zone Without D, D+ Soils

## NO. OF COMMUNITY TYPES

Card 3, spaces 20 and 21.

A diversity of community types contributes to a Natural Area's scenic, recreational, and wildlife habitat values. Indicate the number of community types present in the Natural Area. Distinct vegetation communities should each be counted as 1 community type. These are normally equivalent to areas designated as subsections or sets of similar subsections. Where water bodies or tidal wetlands are contiguous with or enclosed by the Natural Area, but are not included as subsections, each water body type or wetland type should be counted as one community type.

### **COMMUNITY DIVERSITY**

Card 3, space 22.

Indicate the relative number of different vegetation communities and other natural features which the Natural Area contains.

#### Community Diversity

- High contains numerous different vegetation communities, animal habitats or physical features such as streams, bogs, scarps.
- Medium contains a few different vegetation types and habitats or features.
- Low contains predominantly one vegetation community or natural feature.

# **AUDITORY & VISUAL EXPERIENCE**

Card 3, spaces 23 and 24.

Complete the form titled "Auditory and Visual Experience" for the Natural Area. Encode the "Experience Total Score" in the spaces designated on the data form.

Card 3, space 25.

Indicate the Experience Term which the field crew feels most closely describes the Natural Area's Auditory and Visual Experience characteristics relative to other Natural Areas on the Western Shore Coastal Plain.

Experience Term

- 1. Low
- 2. Medium
- 3. High

### WETLAND WILDLIFE RATING

Card 3, spaces 26 and 27.

Complete the "Wetland Wildlife Rating" form and encode the resulting score in the spaces provided, rounding to the nearest whole number.

Instructions for completing the form are included in the notebook under the tab entitled "Wetlands." Complete this form and record the score for all Natural Areas containing one or more of the wetland classes described in the instructions. Included or contiguous open water areas not described as subsections should be included as a wetland class. Otherwise, this rating pertains only to wetlands included in the Natural Area.

### **CATEGORIES**

Card 3, spaces 28-39.

Indicate the three categories which punctuate the most interesting, unusual or most descriptive characteristic of the Natural Area. The priority for choosing a category should follow the general rule of....rare, endangered, unusual, interesting descriptive. All three categories need not be filled out; however, the Primary and Secondary Categories should be filled out whenever possible. Record the number listed on the Category Code Sheets which are included in the field notebook under the tab labeled "Categories." Use the first four spaces labeled "Primary" for the most important characteristics, "Secondary" for the second most important, etc.

## ONE LINE DESCRIPTION

Card 3, spaces 40-76. Card 4, spaces 3-61.

Write a brief sentence or phrase describing the salient characteristic of the Natural Area. You are limited to 98 spaces. Continue this description on Card 4, treating Cards 3 and 4 as one line.

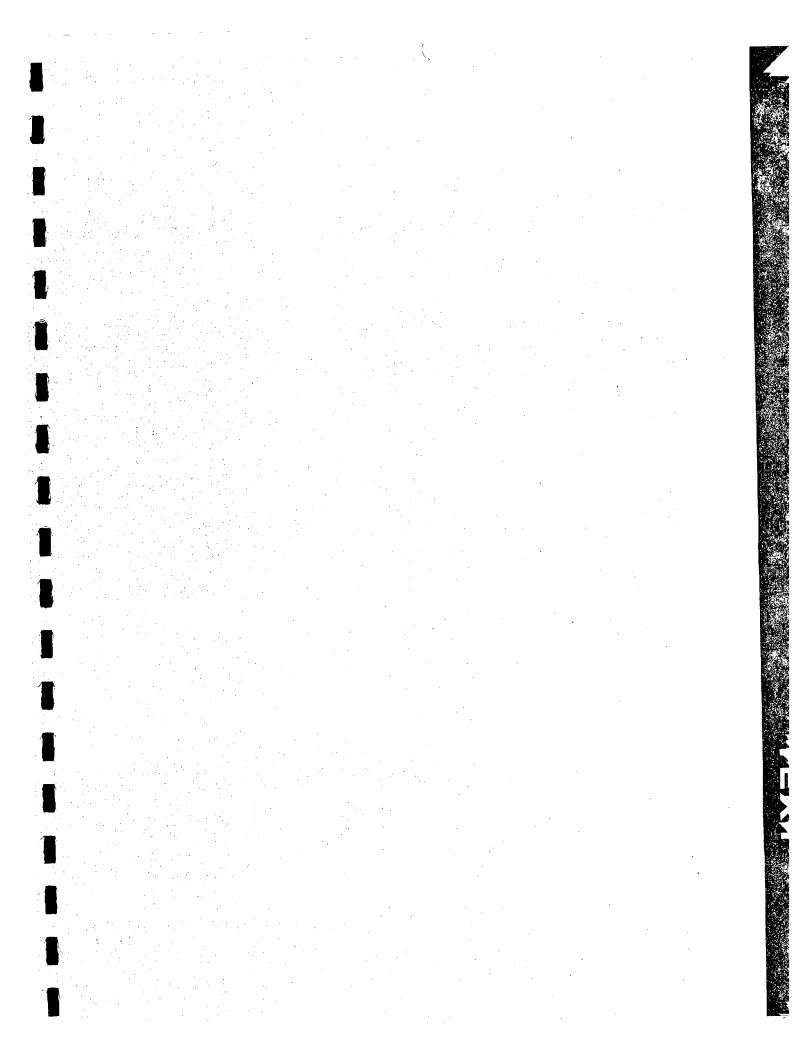
#### For Example:

- 1. Large and active natural spring
- 2. Small bog with nearby hiking trails
- 3. Natural pond, excellent wildlife area
- 4. Large stand of mixed hardwoods with beech predominating
- 5. Large bog and pond, unusual vegetation on both
- 6. Very remote white cedar swamp with rhododendron

### SITE NUMBER

Card 3, spaces 77-80.

Record the site number in the last four spaces on Card 3. This number will automatically be keypunched in the same spaces on Card 4.



### TEXT

Immediately upon completion of the survey, develop a paragraph from notes and Data Forms which includes the following considerations:

- a. Unique, distinctive, or characteristic features of the Natural Area.
- b. Description of the dominant vegetation or, if a mosaic, the types and percent coverage of the Natural Area by each type.
- c. Characteristic DBH, any lack of reproduction, obvious trends or vegetation dynamics.
- d. Disturbances, historical notes.
- e. Unusual animals, importance of the Natural Area for wildlife, geologic features.
- f. Role of Natural Area in the coastal zone aquatic system (i.e. buffer, natural spring, site of high erosion).

See the Data Form entitled "TEXT." Each line on the Form will be entered on a separate computer card and will appear on the computer print-out as one line of the paragraph.

The County and Field Site Numbers should be entered in the appropriate spaces in the upper right corner of the Data Forms.

## **NAMES**

Record the names of any people either listed in the folders or to whom you have spoken with who have information on the Natural Area or who are very knowledgeable about it. See the Data Form entitled "NAMES."

Each line on the Data Form should be used for one name only.

The County and Field Site Numbers should be entered in the appropriate spaces in the upper right corner of the Data Form.

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# SUBSECTION NUMBER

Card 7, spaces 3 and 4.

Record the number assigned to the subsection (e.g. 01, 02, 03 . . .)

## SIMILAR SUBSECTIONS

Card 7, spaces 5-12.

Indicate the subsections which are considered to be "similar subsections." Similar subsections are areas with minor differences in vegetation and comparable water bodies, disturbances and soils. Do not complete an additional Card 7 for the similar subsections. Do complete a vegetation sampling form for each subsection. Where fewer than four similar subsections are designated, leave the unused spaces blank.

### AREA OF SUBSECTION

Card 7, spaces 13-16.

Record the area in acres for the subsection or the set of similar subsections. Right justify the acreage, leaving blanks before the numbers.

## WATERBODY DISTANCE

Card 7, space 17.

Indicate the straight line distance from the subsection to the nearest waterbody. Where the subsection is a waterbody, encode 1 (same as this subsection) as the distance.

#### Water Body Distance

- 1. Same as this subsection
- 2. Included or contiguous (1-10 feet)
- 3. 10-50 feet
- 4. 50-100 feet
- 5. 100-200 feet
- 6. 200-300 feet
- 7. 300-500 feet
- 8. Greater than 500 feet

### WATERBODY TYPE

Card 7, spaces 18 and 19.

Indicate the Water Body Type to which the distance has been recorded. Where one water body is the closest water body for more than one subsection, designate one of these subsections as subsection 01. Complete the remaining water body, beach, and stream parameters for this subsection. Encode 14 (Same as subsection 01) as the Water Body Type for the other subsections for which that water body is closest. When "Same as subsection 01" is recorded as the Water Body Type, do not complete the remaining water body, beach, and stream parameters (leave spaces 20 through 26 blank). If more than one Water Body Type is included or contiguous with the Natural Area, indicate different Water Body Types for different subsections so that all included or adjacent types are described.

#### Water Body Type

- Ol. Primary Stream, < 5 feet wide
  Non-tidal stream with an average width
  of less than 5 feet.
- 02. Secondary Stream, 5-30 feet wide Non-tidal stream with an average width of between 5 and 30 feet.
- 03. Tertiary Stream, > 30 feet wide
  Non-tidal stream with an average width
  greater than 30 feet.
- O4. Tidal Stream
  Streams with tidal influence which appear as a single blue line on the County Topographic Maps.
- 05. Sub-Estuary
  Tidal areas other than the Chesapeake
  Bay or Potomac River which appear as
  a light blue signature (indicating
  width) on the County Topographic Maps
- 06. <u>Potomac River</u>
  The Potomac River proper.
- 07. <u>Chesapeake Bay</u>
  The Chesapeake Bay proper.
- 08. Pond
  Small enclosed body of freshwater,
  often artificially formed.
- 09. Bog
  Waterlogged spongy accumulation of sphagnum moss which may support herbs such as sedges, rushes or scattered shrubs that cover less than 50 percent of the area.

#### Water Body Type (Continued)

10. Freshwater Marsh

Soils normally covered with between 6 inches and 3 feet of water. Vegetation is usually dominated by robust or marsh emergents.

11. Shrub Swamp

Soils are usually waterlogged during the growing season and often covered by standing water. Vegetation is dominated by shrubs including alders, willows, red maple, buttonbush and dogwood.

12. Wooded Swamp
Soils are usua

Soils are usually waterlogged during the growing season and seasonally covered with up to one foot of standing water. Trees include willow oak, green ash, red maple, bald cypress, black gum, etc.

13. Tidal Wetlands

Marshes and swamps which are influenced by the tide.

14. Same as subsection Ol

Closest water body to the subsection is the same water body as that described with subsection Ol.

#### Photo Scale

1:15,840 1 inch = 1,320 feet (Xerox photos, 0.6 mm = 30 feet Cecil County)

### WATERBODY SIZE

Card 7, space 20.

Indicate the size of the water body cited under Water Body Distance. For Water Body Types 01 through 07, encode 7 (Not applicable) under Water Body Size. Where 14 (Same as subsection 01) is encoded for the Water Body Type, leave this space blank.

#### Water Body Size

- 1. Less than 1 acre
- 2. 1-5 acres
- 3. 5-10 acres
- 4. 10-20 acres
- 5. 20-30 acres
- 6. Greater than 30 acres
- 7. Not applicable

# WATERBODY DEPTH

Card 7, space 21.

Indicate whether the water body previously described is greater or less than 1 foot in depth on the average. Where 14 (Same as subsection 01) is encoded for Water Body Type, leave this space blank.

#### Water Body Depth

- 1. Less than 1 foot
- 2. Greater than 1 foot

### WATERBODY BOTTOM MATERIAL

Card 7, space 22.

Indicate the predominant bottom type found in the water body previously described. Where 14 (same as subsection 01) is encoded for Water Body Type, leave this space blank.

#### Water Body Bottom Material

- 1. Peat fibrous organic material with recognizable plant parts.
- 2. <u>Muck</u> black ooze composed of silt and decomposed organic matter.
- 3. Silt fine sediment with little organic material.
- 4. Sand granular sediment.
- 5. <u>Gravel</u> granular sediment with particles larger than 2mm (approximately 1/8 in.).
- 6. Cobble round or sub-round, water-worn rock 2 12-10 inches in diameter.
- 7. Rock solid aggregate of minerals larger than a cobble.

## BEACH TYPE

Card 7, space 23.

Indicate the beach type which occurs along the water body previously described. Where one of 09 through 13 are encoded for Water Body Type record 5 (Not applicable) for Beach Type. Where 14 (Same as subsection 01) is recorded for the Water Body Type, leave this space blank.

#### Beach Type

- 1. <u>Bluff</u> steep slope or abrupt embankment along waterbody edge or sandy beach
- 2. <u>Bank</u> surrounding area gently sloping to waterbody edge
- 3. Sandy Beach low, sloping sandy beach without dunes
- 4. Dunes low, sloping sandy beach with dunes
- 5. Not applicable

## BEACH LENGTH

Card 7, space 24.

Indicate the length of sandy beach which occurs along the water body previously described. Where 14 (Same as subsection 01) is encoded for Water Body Type, leave this space blank. Where no sandy beach occurs on the water body or the Water Body Distance is greater than 10 feet encode 5 (Not applicable) as the Beach Length.

#### Beach Length

- 1. Less than 500 feet
- 2. 500-1000 feet
- 3. 1000-1500 feet
- 4. Greater than 1500 feet
- 5. Not applicable

# **BEACH WIDTH**

Card 7, space 25.

Indicate the width of sandy beach which was described under Beach Length. Where Beach Length was left blank leave this space blank. Where Beach Length was encoded as 5 (Not applicable) record the Beach Width as 5 (Not applicable).

#### Beach Width

- 1. Less than 1 foot
- 2. 1-10 feet
- 3. 10-20 feet
- 4. Greater than 20 feet
- 5. Not applicable

## % OF STREAM SHADED

Card 7, space 26.

Where one of 01 through 04 is encoded for Water Body Type, indicate the percent of the subject stream which is shaded by tree or shrub cover with the sun directly overhead. Where the Water Body Type is not a stream, encode 5 (Not applicable) for % of stream shaded. Where 14 (Same as subsection 01) is encoded for Water Body Type, leave this space blank.

#### % of Stream Shaded

- 0. less than 10%
- 1. 10-25%
- 2. 25-50%
- 3. 50-75%
- 4. 75-100%
- Not applicable

### SOIL TYPE

Card 7, spaces 27-30.

Record the symbols for the dominant soil type which occur within the subsection as indicated on the maps in the county soil survey. Left register all soil type symbols, leaving blanks after the code. Where a subsection such as a pond which has no soil type recorded on the soil survey, encode "W" in the left most box under "Soil Type."

## SOIL DRAINAGE

Card 7, space 31.

Indicate whether well drained soils occur in the subsection. Well drained soil types are listed by symbols under the tab entitled Well Drained Soils in the field notebook.

#### Soil Drainage

- 1. Yes, well drained soils occur in the subsection.
- 2. No, well drained soils do not occur in the subsection.

# **VEGETATION TYPE**

Card 7, spaces 32-34.

Indicate the vegetation type which characterizes the subsection. Forest vegetation types are described in the booklet Forest Cover Types of North America, Society of American Foresters, 1975. Record the vegetation type which best describes the subsection.

#### Vegetation Types

- 14 Northern pin oak
- 16 Aspen
- 21 White pine
- 23 Hemlock
- 29 Black cherry
- 39 Black ash-American elm-red maple
- 40 Post oak-black oak
- 41 Scarlet oak
- 44 Chestnut oak
- 45 Pitch pine
- 46 Eastern red cedar
- 47 Eastern red cedar-pine
- 48 Eastern red cedar-hardwoods
- 49 Eastern red cedar-pine-hardwoods
- 50 Black locust
- 51 White pine-chestnut oak
- 52 White oak-red-oak-hickory
- 53 White oak
- 54 Northern red oak-basswood-white ash
- 55 Northern red oak
- 56 Northern red oak-mockernut hickory-sweetgum
- 57 Yellow poplar
- 58 Yellow poplar-hemlock
- 59 Yellow poplar-white oak-northern red oak
- 60 Beech-sugar maple
- 61 River birch-sycamore
- 62 Silver maple-American elm
- 63 Cottonwood
- 64 Sassafras-persimmon
- 65 Pin oak-sweetgum
- 75 Shortleaf pine
- 76 Shortleaf pine-oak
- 77 Shortleaf pine-Virginia pine
- 78 Virginia pine-southern red oak
- 79 Virginia pine
- 80 Loblolly pine-shortleaf pine
- 81 Loblolly pine
- 82 Loblolly pine-hardwood

#### Vegetation types - continued

- 87 Sweetgum-yellow poplar
- 88 Laurel oak-willow oak
- 91 Swamp chestnut oak-cherrybark oak
- 92 Sweetgum-Nuttal oak-willow oak
- 93 Sugarberry-American elm-green ash
- 94 Sycamore-pecan-American elm
- 95 Black willow
- 96 Overcup oak-water hickory
- 97 Atlantic white cedar
- 98 Pond pine
- 101 Bald cypress
- 102 Bald cypress-water tupelo
- 103 Water tupelo
- 104 Sweetbay-swamp tupelo-red maple
- 107 Robust emergents (Typha spp., etc.)
- 108 Shrub swamp
- 109 Grasses, sedges, rushes
- 110 Floating leaved and submerged vegetation
- 111 Shrub or old field vegetation

### **TOPOGRAPHY**

#### Card 7, space 35.

Indicate the type of topography which typifies the subsection.

#### Topography

- 1. Flat little topographic relief over most of subsection
- 2. Rolling hills with slopes < 15% over most of subsection
- 3. Steep slopes > 15% over most of subsection
- 4. Mixed flat or rolling topography with significant areas (>33%) with steep slopes, gorges, or bluffs

## SOURCE OF DISTURBANCE

Card 7, spaces 36-39.

Indicate the primary and secondary sources of physical alteration which are evident in the subsection. The first two spaces should be used for encoding the dominant type of disturbance. The co-dominant or less devestating type should be recorded in the second pair of spaces.

#### Source of Disturbance

- 1. Channelization
- 2. Dredging
- 3. Sewer Outlet
- 4. Culverts
- 5. Bulkheading
- 6. Dikes
- 7. Dams
- 8. Change in Watertable
- 9. Logs and Debris
- 10. Beaver Dams
- 11. Algal Blooms
- 12. Fedid Odor
- 13. Siltation
- 14. Erosion
- 15. Noise
- 16. Air Pollution
- 17. Selective Cutting
- 18. Clear Cutting
- 19. Fire
- 20. Windthrow
- 21. Disease
- 22. Litter Accumulation, leaf
- 23. Dumping
- 24. Littering, paper
- 25. Vandalism
- 26. Trampling
- 27. Motor Vehicles
- 28. Postagricultural
- 29. Other
- 30. None
- 31. Flooding
- 32. Grazing

### DEGREE OF DISTURBANCE

Card 7, space 40.

Indicate the relative amount of disturbance which is evident in the subsection as a result of man's actions.

### Degree of Disturbance

- 1. <u>Severe</u> man's impact resulting in severe alteration of vegetation or natural feature
- 2. <u>Moderate</u> man's impact resulting in moderate alteration of vegetation or natural feature
- 3. Low man's impact evident but not significant
- 4. None evidence of man-made disturbance not present over most of the subsection

### **PASSAGE**

Card 7, space 41.

Indicate the degree of difficulty a hiker would encounter when walking through the subsection.

### Ease of Passage

- 1. <u>Difficult</u> thick understory or wet mucky soils
- 2. Moderate interspersed understory or wet soils
- 3. Easy open understory, dry soils

### **ANIMALS**

Card 7, spaces 42-66.

Record the code and source for any birds, mammals, and herptiles which are known to occur in the subsection. Six sets of five spaces are provided for citing six species. In the first four spaces of each set, record the four number code for the species. In the fifth space of each set encode whether the animal was observed or heard, reported, or a sign of the species was seen. Where more than 6 species are eligible for citation, encode the more unusual or rare species. If necessary, additional species important to the Natural Area may be encoded in other subsections.

### Animals

Record 4 number code and source for each animal.

Source 1. Observed or Heard

- 2. Reported
- 3. Den, Nest or Spoor

Where known, the residency and frequency of occurence of each animal in Maryland will be automatically printed for each species on the sites computer printout. These are encoded for your reference with each list of species according to the following scheme.

### Residency

- 1. Breeding
- 2. Migratory
- 3. Winter
- 4. Year Round

### Frequency

- 1. Abundant, common
- 2. Fairly common, uncommon
- 3. Rare
- 4. Endangered

### SITE NUMBER

Card 7, spaces 77-80.

Record the County Site Number and Field Site Number in the last four spaces of Card 7.

### VEGETATION SAMPLING

Locate sampling stations in areas of each subsection which fairly represent the character of the community as a whole. These sampling stations should be chosen to meet the following criteria:

- a. The vegetation shall be located on a uniform topographic site, i.e. on the exposure, slope position, and geological substrate.
- b. The sample area shall generally reflect the character of the mapping unit within which it is located.

At each sampling point, first measure basal area by tallying trees with a BAF-10 wedge prism. A properly ground and calibrated prism is merely a tapered wedge of glass that bends or deflects light rays at a specific offset angle. When a tree stem is viewed through such a wedge, the bole appears to be displaced, as if seen through a camera range finder. The prism is rotated above a sampling point for a 360 degree circle. Use of the prism requires that it be held precisely over the sampling point at all times, for this point and not the observer's eye is the pivot from which the stand is swept. All tree stems not completely offset at 4.5 feet above the ground when viewed through the wedge are counted; others are not tallied. Trees that appear to be borderline should be measured and checked with the appropriate plot radius factor before arbitrarily deciding to tally every other borderline stem. A tree which forks below 4.5 feet is tallied as two trees; a tree which forks above 4.5 feet is counted as one.

The prism may be held at any convenient distance from the eye, provided it is always positioned directly over the sampling point. Proper orientation also requires that the prism be held in a vertical position and at right angles to the line of sight; otherwise, large errors in the tree tally may result. A complete explanation of point sampling and instructions for using the wedge prism are included in the reprint following the sampling instructions.

Record the number of trees counted at each sample point on the "Vegetation Sampling Form" in the box marked "Tally" above the proper sample number. At the completion of the survey, record the total number of trees counted in each subsection and the number of basal area samples taken in the proper boxes at the top of the "Vegetation Sampling Form."

A Basal Area Factor-10 prism has an offset angle of 104.18 min. With this viewing angle, all trees no farther than 33 times their diameter from the sample point are tallied. As a result of this relationship, each tree counted represents 10 square feet of basal area/acre at 4.5 feet above the ground. (Basal area is the cross sectional area of a tree stem.) For each subsection, the computer will divide the total number of trees tallied by the number of sample points and multiply this quotient by 10 to get the basal area/acre of the subsection in square feet. This will give an idea of the relative density of trees in different subsections.

The number of trees counted in each subsection using the prism is dependent on both the diameter of the trees in the stand and their spacial distribution. The accuracy of the resulting basal area measurement is

dependent on the variability of these two factors. For this reason, diverse stands require a higher sampling intensity than even-aged stands of low diversity. As a rule of thumb, a minimum of 4 samples is required for a monotypic, single-aged stand such as a pine plantation; up to 10 samples are required for mixed-aged stands with a diversity of species such as a mixed hardwood forest.

As a representation of the species composition of each subsection, the vegetation should be described for each physiognomic strata. The canopy is the highest forest layer. The understory is composed of trees of intermediate height. The shrub layer lies below the understory and is generally composed of species with multiple stems less than 20 feet tall. The herb layer is within a few feet of the ground but may contain woody species such as partridgeberry, poison ivy, etc. Where vines extend into the canopy and understory, record them with the herb layer and note them in the text. Estimate and record percent cover by species for each layer under the appropriate sample point number on the "Vegetation Sampling Form." Record average DBH (Diameter Breast Height - diameter at 4.5 feet above the ground) for the canopy species. Record this information at a sufficient number of sampling points to adequately reflect the composition of the community. Generally, fewer of these samples will be required than basal area samples, but a basal area sample should be taken at each of these vegetation sample points.

At the completion of the survey, average the DBH and percent cover estimates for each species and record these in the proper spaces at the left of the "Vegetation Sampling Form." Average the percent cover for each layer and note these at the top. Encode the layer for each species and note impact where applicable. Finally, encode the number for each species as found on the lists which follow in the notebook.

If conditions do not permit doing Basal area samples and no prism samples are taken, leave "No. Samples" and "Total Tally" blank. <u>Do not put "O"'s in these spaces</u>. An "O" should only be used in "No. Samples" if 10 samples are taken.

### Reprinted from:

Avery, Eugene T. Ph.D. 1967. Forest Measurements. McGraw-Hill Book Company, New York.

### POINT-SAMPLE TIMBER CRUISING

### A NEW ANGLE TO CRUISING

10-1 The concept of point sampling. In its most elementary form, point sampling is merely a method of selecting trees to be tallied on the basis of their sizes rather than by their frequency of occurrence. Sample "points," somewhat analogous to plot centers, are randomly or systematically located within a forested tract, and a simple prism or angle gauge that subtends a fixed angle of view is used to "sight in" each tree dbh. Tree boles close enough to the observation point to completely fill the fixed sighting angle are tallied; stems too small or too far away are ignored. Thus the probability of tallying any given tree is proportional to its BA, and consequently more time is spent on larger, high-value trees than is the case with conventional strip or line-plot cruising.

The concept of point sampling was developed and first reported in

subsequent volume computations, it is desirable to select a sighting angle having a BAF that can be expressed as a whole number rather than tribution of trees to be sampled. Furthermore, from the standpoint of ing angle chosen, in turn, is largely based on the average size and disas a fractional number.

In Eastern United States, a predetermined sighting angle of 104.18 min (BAF of 10 sq ft per acre) is commonly used in second-growth sawtimber or dense pole-timber stands. Critical angles of 73.66 min (BAF 5) and 147.34 min (BAF 20) are often employed for light-density pole scattered stems, the sighting angle is narrowed so that it will extend farther out for trees of minimum diameter; conversely, where large tree diameters are common, the angle is enlarged to reduce excessively heavy stands and for large, old-growth sawtimber, respectively. With small,

24"PIAM DIAM 12 DIAM DIAM ø ,6<sup>5</sup>, SAMPLING

FIG. 10.1 Ratio of tree diameter to plot radius for 8AF 10, Adapted from Hovind and Rivels, 1961.

POINT SAMPLE TIMBER CRIT

due to the efforts of Lewis R. Grosenbaugh, a biometrician with the U.S. Forest Service. Grosenbaugh recognized the potentialities of the angle-gauge idea and expanded it into a complete inventory system that has largely supplanted strip, and line-plot cruising in many regions. In the United States, the technique is usually referred to as the Bitterlich 1948 by Walter Bitterlich, a forest engineer of Salzburg, Austria. The introduction and adoption of the method in North America were largely system or simply as point sampling. These two terms are generally favored over variable-plot sampling or plotless cruising.

ished relationship between tree BA and volumes also makes it feasible to use point sampling for obtaining conventional timber inventory data when "counted" trees are recorded by merchantable or total height area factor (BAF) of 10 sq ft per acre is assumed and a total of 75 trees is tallied on 15 sample points, the average of five trees per point multi-10-2 The basal area approach. Point sampling does not require measurements of either plot areas or tree diameters. If a predetermined basal plied by 10 provides a BA estimate of 50 sq ft per acre. The well-estabclasses. 10-3 Selecting a sighting angle. BA conversion factors are dependent on the sighting angle (or "critical angle") arbitrarily selected. The sight-

# TABLE 10-1 Common Basal Area Factors and Angle Sizes Used in

Point Sampling

| Basal<br>urea<br>factor | Angle size,<br>min | Angle size,<br>diopters | Ratio (tree diameter to plot radius) | Plot radius<br>factor |
|-------------------------|--------------------|-------------------------|--------------------------------------|-----------------------|
| -                       | 32.94              | 0.96                    | 1/104.4                              | 8.696                 |
| ଧ                       | 46.59              | 1.36                    | 1/73.8                               | -6.149                |
| 85                      | 57.06              | 1.66                    | 1/60.2                               | 5.021                 |
| ಈ                       | 65.89              | 1.09                    | 1/52.2                               | 4.348                 |
| מו                      | 73.66              | 2.14                    | 1/46.7                               | 3.889                 |
| 10                      | 104.18             | 3.03                    | 1/33.0                               | 2.750                 |
| 12                      | 127,59             | 3.71                    | 1/26.9                               | 2.245                 |
| 윉                       | 147.34             | 67.7                    | 1/23.3                               | 1.944                 |
| ž.                      | 164.73             | 4.79                    | 1/20.9                               | 1.739                 |
| 30                      | 180.46             | 5.25                    | 1/19.0                               | 1.588                 |
| 器                       | 194.92             | 5.67                    | 1/17.6                               | 1.470                 |
| Ç                       | 208.38             | 6.07                    | 1/16.5                               | 1.375                 |
| 50                      | 232.99             | 62.9                    | 1/14.8                               | 1.230                 |
| ()(9                    | 255, 23            | 7.1.                    | 1/13.5                               | 1.123                 |
|                         |                    |                         |                                      |                       |

SOURCE: Hovind and Ricck, 1961

Depending on the region, average tree size, and amount of underbrush restricting line-of-sight visibility, the BAF is usually chosen to provide an average tally of 5 to 12 trees per sample point. In Western United States where larger timber predominates, a BAF of 20 to 60 is in common use. For "West Side" Douglas fir, a BAF of 40 might be regarded as typical, but an instrument with a BAF of 20 would be more frequently encountered in sampling stands of "East Side" ponderosa pine.

listed in Table 10-1, a sighting angle of 104.18 min (BAF 10) may be presumed. As this angle can also be defined by placing a 1-in. horizontal intercept on a sighting base of 33 in. (column 4 of Table 10-1), it follows that all trees located no farther than 33 times their diameter from the sample point will be tallied. Accordingly, a 1-in. dbh tree must be within 33 in. of the point, a 12-in.-dbh tree will be tallied up to 396 in. (33.0 ft) away, and a 24-in. or 2-ft-dbh tree will be recorded up to a distance of 66 ft (Fig. 10-1). This 1:33 ratio of tree diameter to plot radius, a constant for the specified angle of 104.18 min, has a value of 2.75 ft (33 ÷ 12) when expressed as a "plot radius factor." Thus for each full inch added to stem diameter, a tree can be 2.75 ft farther from the sample point and still be tallied.

### HOW POINT SAMPLING WORKS

10-5 Imaginary tree zones. As the plot radius factor for BAF 10 has been developed in the preceding section, all subsequent explanations of point-sampling theory and tree volume conversions in this chapter will presume a sighting angle of 104.18 min and a BAF of 10 sq ft per acre. Nevertheless, the underlying principles discussed may be applied to any other angle or BAF.

Because each tree "sighted in" must be within 33 times its diameter of the sample point to be tallied, it is convenient to presume that all trees are encircled with imaginary zones whose radii are exactly 33 times the diameter of each tree stem. All these imaginary circles that encompass a given sampling point on the ground represent trees to be tallied (Fig. 10-2). Thus the probability of tallying any given tree is proportional to its stem B.A. A 12-in. dbh has four times the probability of being counted as a 6-in.-dbh stem. Stated in another way, the chances of tallying one 12-in.-dbh tree are the same as that of encountering four 6-in.-dbh trees.

10-6 Equality of trees on a per acre basis. For the sighting angle of 104.18 min, each tallied tree (regardless of its size or relative position to the sampling point) represents 10 sq ft of BA on a per acre basis.

The reason for this is that each stem and its imaginary zone "represent" a definite part of an aere and a specific number of trees per aere, depending on its size. The derivation of values for 6-in.- and 12-in.-dbh trees in Table 10-2 provides an explanation or "proof" of this theory.

Considering the 6-in. dbh first, its imaginary "plot" radius is read from Table 10-2 as 16.50 ft. This hypothetical zone represents an imaginary plot of 0.0196 acre around each 6-in-dbh stem (column 3 of

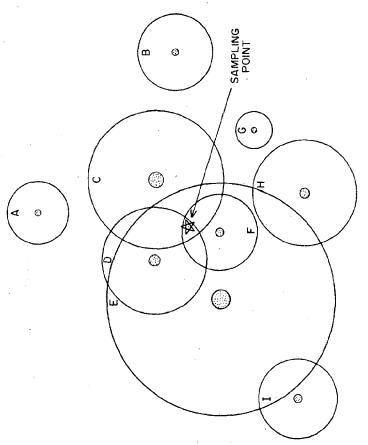


FIG. 10-2 Imaginary zones proportional to stem diameter and encircling each tree determine which trees will be tallied at a given point.

Adapted from Hound and Ricck, 1961.

Table 10-2). By dividing 0.0196 into 1.00 aere, it can be seen from column 4 that there can be 51.02 such areas fitted into a single acre. Thus when one 6-in.-dbh tree is tallied, it is taritly assumed that there are 51.02 such stems per acre. Accordingly, the BA of a 6-in.-dbh tree (0.196 sq ft from column 5), multiplied by 51.02 trees per acre, yields the "constant" BAF of 10 sq ft per acre (column 6).

For 12-in.-dbh stems, the imaginary plot radius is 33.00 ft, and the

ABLE 10-2 Derivation of the Basal Area Factor of 10 Sq Ft Per Acre for Point Sampling

| Free dbh,                | Imaginaty<br>slot redius | Imaginary                | Trees per         | Basal area          | Basal area   |
|--------------------------|--------------------------|--------------------------|-------------------|---------------------|--------------|
| <u>.</u>                 | proceeds,                | piot size,               | no. of stems      | sa ft               | sq ft        |
| (1)                      | (i)                      | (3)                      | ( <del>†</del> )  | ·(c)                | (9)          |
| 7                        | 11.00                    | 0.0087                   | 114.94            | 0.087               | 10           |
| . 9                      | 06.31                    | 0.0196                   | 51.02             | 0.196               | 10           |
| œ                        | 22.00                    | 0.0349                   | 28.65             | 0,349               | 10           |
| . 01                     | 27.50.                   | 0.0545                   | 18.35             | 0,545               | 10           |
| 12                       | 33.00                    | 0.0785                   | 12.74             | 0.785               | 01           |
| 14                       | 38.50                    | 0.1069                   | 9.35              | 1.069               | 10           |
| . 91                     | 44.00                    | 0.1396                   | 7.16              | 1.396               | 10           |
| 18                       | 00.04                    | 0.1767                   | 5.66              | 1.767               | 10           |
| 50                       | 55.00                    | 0.2182                   | 4.58              | 2.182               | 10           |
|                          | 60.50                    | 0.2640                   | 3.79              | 2.640               | 10           |
| 24                       | 00.99                    | 0.3142                   | 3.18              | 3, 142              | 01           |
| 56                       | 71.50                    | 0.3687                   | F. 51             | 3.687               | 10           |
| 28                       | 00.12                    | 0.4276                   | 2.34              | 4.276               | . 01         |
| 30                       | 82.50                    | 6064.0                   | 2.04              | €.909               | 01           |
| 32                       | 88.00                    | 0.5585                   | 1.79              | 5.585               | 10           |
| 34                       | 93.50                    | 0.6305                   | 1.59              | 6.305               | 01           |
| 36                       | 99.00                    | 0.7069                   | 1.41              | 69012               | 10           |
| Method of<br>calculation | dbh × 2, 75              | $\frac{\pi r^2}{43,560}$ | 1 00<br>plot size | $0.005454D^{\circ}$ | column 4 × 5 |
|                          |                          |                          |                   |                     |              |

<sup>\*</sup> Exact value for number of trees per acre may vary slightly, depending upon number of decimal places expressed for imaginary plot size.

implied plot size is 0.0785 acre. Only 12.74 trees per acre are assumed—approximately one-fourth the number of 6-in,-dbh trees expected. However, 12-in,-dbh trees have four times the BA of 6-in,-dbh steins, and this value (0.785 sq ft) from column 5, multiplied by 12.74 trees per acre, again produces a BA of 10 sq ft per acre. The same "proof" applies to all other tree sizes encountered when sampling with a BAF 10 angle

### INSTRUMENTS FOR POINT SAMPLING

10-7 The stick-type angle gauge. This simple, horizontal angle gauge often consists of a wooden rod with a peep sight at one end and a

metal intercept at the other. To establish a sighting angle of 104.18 min (BAF 10), an intercept 1 in, wide on a 33-in, sighting base can be easily improvised, Gauges for other factors can be constructed according to ratios provided in Table 10-1. Regardless of the ratio desired, the sighting base should be at least 24 in, long; otherwise, it is difficult to keep both the intercept and the tree in focus simultaneously.

When the stick gauge is used, all tree diameters larger than the defined angle are counted; those smaller are ignored. Trees that appear to be exactly the same size as the intercept should be checked by measuring their exact dbh and distance from the sampling point. The product of dbh and the appropriate plot radius factor (2.75 for BAF 10) determines whether the tree is "in," "out," or a borderline case. Truly borderline trees are rare, but if they are encountered, they should be tallied as ½ tree.

With a stick gauge, the observer's eye represents the vertex of the sighting angle: hence the stick must be pivoted or revolved about this exact point for a correct tree tally. When properly calibrated for use by a particular individual, the stick gauge may be just as accurate as other more expensive point-sampling devices. In dense sapling or pole stands and where heavy underbrush is encountered, the stick gauge is often easier to use than more sophisticated relascopes or prisms.

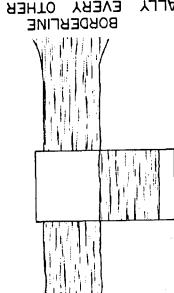
developed for point sampling by Walter Bitterlich. It is a compact and rugged device that may be used for determining BA per acre. upper-stem diameters, tree heights, horizontal distances of 66 and 99 ft with correction for slope, and measurement of slope on per cent, degree, and topographic scales. Sighting angles are provided for factors of 5, 10, 20, or 40, and the instrument automatically corrects each angle for slope. The base has a tripod socket for use when especially precise measurements are desired.

Establishment of sighting angles with the Spiegel relascope is somewhat analogous to incasuring distances with transit and studia rod; the principal difference is that the relascope subtends a horizontal angle, and the transit and studia system is based on a vertically projected angle. The Spiegel relascope is complex in design but relatively simple to use. Its principal disadvantages are that it is relatively expensive and lacks the optical qualities for good sighting visibility on dark and rainy days.

10-9 The wedge prism. A properly ground and calibrated prism is merely a tapered wedge of glass that bends or deflects light rays at a specific offset angle. When a tree stem is viewed through such a wedge,

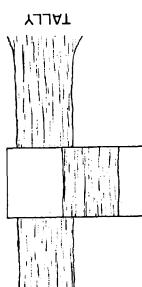
170

173

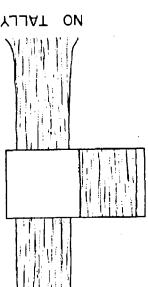








-89-



Adapted from Bruce, 1955. tor Choint sampling. wedge prism

FIG. 10-3

the bole appears to be displaced, as if seen through a camera range finder. The amount of offset or displacement is controlled by the prism strength, measured in diopters. As one prism diopter is equal to a right angle displacement of one unit per 100 units of distance, a 3.03-diopter prism will produce a displacement of one unit per 33 units of distance, i.e., a critical angle of 104.18 min. Other prism-strength relationships are given in Table 10-1.

ONE

is the pivot from which the stand is "swept" by a 360° circle. All tree Field use of the prism requires that it be held precisely over the sampling point at all times, for this point and not the observer's eye stems not completely offset when viewed through the wedge are counted; others are not tallied (Fig. 10-3). Trees that appear to be borderline should be measured and checked with the appropriate plot radius factor before arbitrarily deciding to tally every other borderline stem.

The prism may be held at any convenient distance from the eye, provided it is always positioned directly over the sampling point. Proper orientation also requires that the prism be held in a vertical position and at right angles to the line of sight; otherwise, large errors in the tree tally may result (Fig. 10-4)

accurate as other angle gauges when properly calibrated and used. Some when slopes of 15 per cent and greater are encountered. However, the sighting difficulties are found in dense stands where displaced bole sections offset into one another, and special corrections must be applied atter disadvantage may be cited for all point-sampling devices except The wedge prism is simple, relatively inexpensive, portable, and the Spiegel relascope. 10-10 Calibration of prisms or angle gauges. Precision-tested prisms and angle gauges should be used whenever feasible, because a BAF of exactly 5, 10, or 40 is conducive to faster computations than such min of a specified angle are desired, for such deviation will usually values as 4.9, 9.8, or 39.5 (Sec. 10-3). Prisms ground to within  $\pm 1$ result in a maximum error of about 2 per cent for a BAF 10 prism.

BAF is unknown, such devices should be carefully calibrated. As individual eyesights may vary appreciably, it may even be desirable to Where mexpensive prisms or angle gauges are employed and the exact calibrate all instruments (regardless of price or supposed precision) for each cruiser's own sighting habits or peculiarities.

To calibrate a prism or angle gauge, a target of known width (for example, 1.0 ft) is set up against a contrasting background. With the from the target until the target exactly fills the sighting angle (or until angle gauge or prism in proper orientation, the observer backs away the prism image is displaced as shown for the "borderline" tree in Fig.

10-3). The exact distance from target to instrument is then measured and the BAF computed by this relationship:

$$BAF = 10.890 \left(\frac{W}{D}\right)^2$$

where W is the target width in feet, and D is the distance to target

The foregoing formula is not exact when a flat target is used in calibration but only when the target is a circular cross section with diameter W

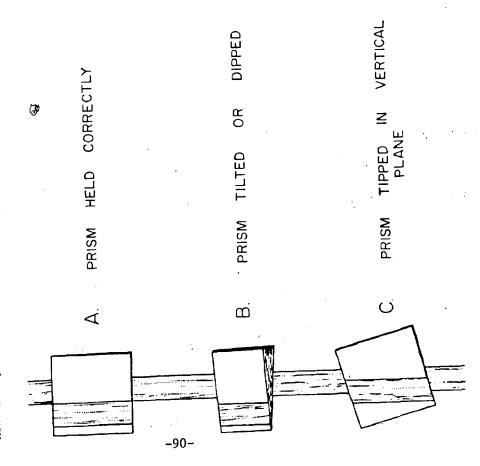


FIG. 10.4 Correct and incorrect methods of holding the wedge prism. Adapted from Horind and Ricck, 1961.

With small critical angles, however, this simple approximation is usually satisfactory, because of the near equality of sine and tangent functions for narrow angles. For reliable results, the instrument should be mounted on a plane table, tripod, or vise and several readings made of the horizontal distance to the target. When a fractional BAF is derived, conversions similar to those in Table 10-2 should be prepared to simplify subsequent inventory computations.

10-11 Corrections for slope. Unless the Spiegel relascope is used to establish sighting angles, corrections must be made in point sampling when slope is 15 per cent or greater, that is, a 15-ft rise or drop in elevation per 100 horizontal feet (Stage, 1959).

When the wedge prism is used, an approximate on-the-ground compensation for slope can be made by tilting the top edge of the prism through the estimated slope angle—at right angles to the line of slope.

TABLE 10-3 Slope Correction Table for Point Sampling\*

| Maximum per cent<br>of slope at<br>sampling point | Maximum degrees<br>of slope at<br>sampling point | Multiply tree<br>count by— |
|---|--|----------------------------|
| 15  | 6.75   | 1.01                       |
| 20  | 9.00   | 1.02                       |
| 25  | 11.25  | 1.03                       |
| 30  | 13.50  | 1.04                       |
| 35  | 15.75  | 1.06                       |
| 0#  | 18.00  | 1.08                       |
| 45  | 20,25  | 1.10                       |
| 50  | 22, 50   | 1.12                       |
| 55  | 24,75  | 1.14                       |
| . 09  | 27.00  | 1.17                       |
| 65  | 29, 25   | 1.19                       |
| 20 .  | 31.50  | 원.<br>전                    |
| 22  |  | 1.25                       |
| SO  | 36.00  | 1.28                       |
|   | SS 25  | 1.31                       |
| 00  | 40.50  | 1.34                       |
|   | 42.75  | 1.38                       |
| 100   | 45.00  | 1.41                       |

<sup>\*</sup>This correction for tree count, BA, and volume per acre is true only when it is assumed that in this sampling procedure a proportionate number of trees will be added when the slope distance is corrected to the true horizontal distance. For all practical purposes, however, tree count, BA, and volume can be corrected by using the above multipliers.

in per cent or degrees and (2) applying corresponding correction factors to BA or volume per acre estimates from Table 10-3. The amount of can be corrected by (1) measuring the slope at right angles to the contour With angle gauges such as the stick type, the unadjusted field tally slope is usually measured with an Abney level.

pling point to the stem center is precisely equal to tree dbh times plot sess some degree of observer bias when "sighting in" doubtful trees. In a strict sense, borderline trees occur only when the distance from the samradius factor. Therefore, if doubtful trees are regularly checked by care-10-12 Doubtful trees, limiting distances, and bias. Most cruisers posful measurement, the borderline tree is rarely encountered.

To encourage regular field checks of doubtful trees and speed up the

TABLE 10-4 Horizontal Limiting Distances in Feet for BAF 10 Point-sampling Instruments

| Dbh', in. | 0.0   | 0.1   | 0.5   | 0.3   | 0.4   | 0.5    | 9.0   | 0.7   | 0.8   | 0.0   |
|-----------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|
| ro        | 13.75 | 14.02 | 14.30 | 14.57 | 14.85 | 15.12  | 15.40 |       |       |       |
| 9         | 16.50 | 16.77 | 17.05 | 17.32 | 17.60 | 17.87  | 18.15 | 18.42 | 18.70 | 18.97 |
| 2         | 19.25 |       |       |       |       |        |       |       |       |       |
| <b>∞</b>  |       | 22.27 | 22.55 | 22.82 | 23.10 |        | 23.65 |       |       |       |
| 6         |       |       |       |       |       |        |       | •     | -:    |       |
| 10        |       |       |       |       |       | 28.87  |       |       |       |       |
| 11        | 30.25 |       |       | 31.07 |       |        |       |       |       |       |
| 12        |       | 33.27 |       |       |       |        |       | 34.92 | 35.20 |       |
| 13        |       |       |       |       |       | 37, 12 |       |       |       | 38.22 |
| 14        | •     | 38.77 | 39.05 | 39.32 | 39.60 | 39.87  | 40.15 | 40.42 | 40.70 | 40.97 |
| 15        |       |       |       |       | 42.35 |        | 42.90 |       |       |       |
| 16        | 44.00 | 44.27 |       | 44.82 | 45.10 | 45.37  | 45.65 | ,     |       |       |
| 17        |       |       | 47.30 | 47.57 | •     |        |       | 48.67 | 48.95 | 49.22 |
| 18        |       |       |       |       |       | 50.87  |       |       |       |       |
| 19        |       |       |       |       |       |        |       |       |       |       |
| 20        | 55.00 | 55.27 | 55.55 | 55.82 | 56.10 | 56.37  | 56.65 | 56.92 | 57.20 |       |
| 21        |       |       | 58.30 | 58.57 | 58.85 | 59.12  | 59.40 | 59.67 | 59.95 | 60.22 |
| 22        | 60:50 | 60.77 |       |       |       |        | 62.15 |       |       |       |
| 23        | 63.25 | 63.52 | 63.80 |       | 64.35 | 64.62  |       | 65.17 | 65.45 | 65.72 |
| 24        |       |       |       |       |       | 67.37  |       | ٠.    |       |       |
| 25        | 68.75 | -     | 69.30 | 25.69 | 69.85 |        | 70.40 | 70.67 | 70.95 |       |
| 56        |       | 71.17 | 72.05 | 72.33 |       | 72.87  | 73.15 | 73.42 | 73.70 |       |
| 27        |       |       | 74.80 |       |       |        |       |       |       |       |
| . 82      | 77.00 | 77.27 |       | 77.82 | 78.10 | 78.37  | 78.65 | 78.92 | 79.20 | 79.47 |
| 53        | 79.75 |       |       |       | 80.85 | 81.12  | 81.40 | 81.67 |       |       |
| 30        |       | 82.77 | 83.05 | 83.32 |       |        | 84.15 | 84.42 | 84.70 |       |

in advance of fieldwork. These are easily prepared by multiplying varisampling process, it is helpful to compile tables of limiting distances ous tree diameters by the appropriate plot radius factor (Table 10-4). For maximum utility, such tables should be expressed in feet and links.

When brush or other obstructions make it necessary to move from the sampling point to view certain stems, special care must be exercised to maintain the correct distances from obscured trees. Failure to maintain proper distance relationships can result in sizable errors in the tally, especially when using a large BAF.

sampling sighting gauge is largely a matter of balancing such factors and carefully used. Accordingly, the following generalizations will be 10-13 Chaice of instruments. In summary, the selection of a point as costs, efficiency, and personal preferences. All the devices described here will provide a reliable tree tally if they are properly calibrated primarily useful to the newer advocates of point sampling:

- be used. The prism is particularly desirable for persons who wear eyeglasses, because the vertex of the sighting angle occurs at the prism rather than For relatively flat topography, either the wedge prism or the stick gauge may at the observer's eye. However, the prism is difficult to use in dense stands When steep slopes are regularly encountered, the Spiegel relascope is preferred. due to displacement of stem sections into one another.
- reliable, because there are fewer ways for errors to result with this device The simple stick gauge, though largely supplanted by the prism, is preferable in dense stands-especially if the cruiser does not wear spectacles. Cruisers who use point sampling only occasionally will find the stick gauge more than with the wedge prism.

### VOLUME CONVERSIONS

tallied in point sampling, regardless of its diameter, represents the same 10-14 Tree count and basal area. As previously described, each tree amount of BA on a per acre basis. BA per acre for any tract may thus be computed by this relationship:

BA per acre = 
$$\frac{\text{total trees tallied}}{\text{no. of points}} \times \text{BAF}$$

If the BAF is 10 and 160 trees are tallied at 20 sample points, the BA per acre would be  $160/20 \times 10 = 80$  sq ft per acre. As with all crusing techniques, it is presumed that the counted trees are representative of the population sampled. 10-15 Derivation of tree volumes. Most cruisers are interested in vol-When using point sampling, volume computations are handled differently umes expressed in board feet, cubic feet, or cords rather than BA alone.

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BA per acre. The variable of dbh (a function of BA) can therefore be ignored when only total volumes are required, and the field tally can be reduced to a simple stem count by height classes. Average stand volume per acre is determined by using ratios of the volumes of each height class to their respective BA. These ratios or volume factors can be quickly determined by use of the "per acre conversion factors" in Table 10-2 and the volume of one tree of a specified size. Volume per acre can thus be derived by this relationship:

Volume per acre = (volume per tree)(no. trees per acre)

To illustrate the computation of volume per acre conversions, it may be assumed that cordwood factors are desired for 1-bolt (8 ft of merehantable height) trees in the Lake states by five tree diameter classes. Essential steps in deriving these converting factors can be illustrated in tabular form:

| Merchantable<br>height,<br>ft | Corresponding<br>dbh class, in. | Volume per<br>tree, ed           | Trees per acre<br>(Table 10-2),<br>no. of stems | Volume per acre, (column 3 × 4) |
|-------------------------------|---------------------------------|----------------------------------|---|---------------------------------|
| & & & & &                     | 6<br>8<br>10<br>12              | 0.017<br>0.031<br>0.040<br>0.070 | 51.02<br>28.65<br>18.35<br>12.74                | 0.87<br>0.89<br>0.90<br>0.89    |
| ာတ                            | : <del>*</del>                  | 0.095                            | 9,35  | 68.0                            |

For the single 8-ft-height class listed, it will be noted that volume per acre conversions show very little change from one dbh class to another. Hence, unless stand tables are required, it is superfluous to break down the tally by diameter classes. As shown here, a volume factor of 0.9 ed will suffice for all 8-it heights, irrespective of diameter changes. For other height classes, volume per acre factors might be computed as follows:

| Volume per<br>acre.<br>(column 3 × 4)           | 0.80 ± 0.9<br>1.52 ± 1.5<br>1.97 = 2.0<br>2.52 ± 2.5<br>2.63 ± 2.5<br>3.50 ± 3.0<br>3.40 ± 3.0 |
|---|--|
| Trees per acre<br>(Table 10-2),<br>no, of stems | 28. 12. 12. 13. 13. 13. 13. 13. 13. 13. 13. 13. 13   |
| Volume per<br>tree, ed                          | 0.083<br>0.083<br>0.155<br>0.209<br>0.209<br>163.0   |
| Corresponding<br>dbh class, in.                 | x 5 5 7 7 8  |
| Merchantable<br>height,<br>ft                   | × 9 7 7 7 8 4  |

To review the foregoing computations, the height classes desired for field tallying are listed first in column 1. The average dbh that corresponds to each height class must be obtained from existing, records or special field samples (column 2). With these two values known, the volume per tree (column 3) is read from any desired tree volume table. Number, of trees per acre-(column 4), based on the appropriate dbh class, may be read directly from Table 10-2 for BAF 10 conversions—or computed as described in Sec. 10-6. Finally, the volume per acre conversion (column 5) is simply a product of volume per tree and number of trees per acre.

10-16 Field tally by height classes. The reason that point sampling appears to be such a simple method of deriving standing tree volumes is that most of the computational work is accomplished in advance of the field tally. When the volume per acre conversions are incorporated directly into the field tally form and trees are recorded by height classes only, a minimum of post-cruising calculations are necessary. Under these conditions, the field record essentially becomes a cumulative tally sheet and volumes can be speedily summarized (Table 10-5).

TABLE 10-5 Simplified Field Tally and Volume Summary for Point Sampling

| Tract: La Crosse<br>No. of points: 20 | Tract: La Crosse, Wisconsin<br>No. of points: 20 | Timbered area: 40 acres<br>BAF: 10  | ) acres           |
|---------------------------------------|--|-------------------------------------|-------------------|
| Height class,                         | Tree tally,<br>no. of stems                      | Volume per aere, Tally X volume, ed | Tally × volume cd |
| os.                                   | 50   | 0.9                                 | 18.0              |
| 16                                    | 98   | 1.5                                 | 45.0              |
| 24                                    | 0 <del>1</del>                                   | 2.0                                 | 80.0              |
| 32                                    | <del>5</del> 7                                   | 5.5                                 | 50.0              |
| 40                                    | 10   | 3.0                                 | 30.0              |
| 48                                    | .c   | 3.5                                 | 17.5              |
| Totals                                | 125 Trees  |                                     | 240.5 cd          |

BA per acre =  $\frac{125 \text{ trees}}{20 \text{ points}} \times 10 = 62.5 \text{ sq ft per acre}$ 

Average volume per arre =  $\frac{240.5 \text{ cd}}{20 \text{ points}}$  = 12.025 cd per acre

When stand and stock tables are needed and trees must also be listed by diameter classes, special cumulative tally sheets have been published (Thornton and Hutchison, 1958).

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### POINT-SAMPLE CRUISING INTENSITY

ever, approximations can be made on the basis of the average stem nary plot radius (depending on the BAF used), and the exact plot size cannot be easily determined, even after the tally has been made. Howsity on a conventional area-sample basis. Each tree has its own imagi-Comparisons with conventional plots. There is no fixed plot size when using point sampling; hence it is difficult to compute cruise intendiameter encountered at a given point.

about 1/12 aere. To sample a full 15 aere, average dbh would have of 6  $\times\,2.75$  or 16.5 ft—equivalent to about 15.0 acre. If the dbh class were doubled to 12 in., the effective sample area would quadruple to and a critical angle of 104.18 min, the area sampled would have a radius Assuming an even-aged plantation with a single dbh class of 6 in. to be about 19 in.

sampling is adopted, the so-called borderline trees must always be closely checked, for the cironeous addition or omission of a single stem reduces selection of trees according to size rather than frequency may more than offset this reduction of sample size—and with an additional saving in time. Conversely, it must be remembered that smaller samples of any kind require larger expansion or blow-up factors. Thus when point From the foregoing, it follows that use of BAF 10 sample points in in a tally of fewer trees. From a statistical standpoint, however, the lieu of the same number of 1/4- or 1/4-acre plots will usually result the accuracy of any volume estimate by the amount of the BAF. -93-

sampling intensity may be derived from Table 8-1 or by formulas demine the standard deviation (or coefficient of variation) of BA or volume scribed in Secs 8-15 and 8-16. If the statistical approach is not feasible, of determining how many point samples should be measured is to deterper acre from a preliminary field sample. When this has been done, 10-18 Number of sampling points needed. The only accurate method the following rules of thumb will often provide acceptable results:

- 1 If the BAF is selected according to tree size so that an average of 5 to 12 trees are counted at each point, use the same number of points as 1/6-acre
  - With a BAF 10 angle gauge and timber that averages 12 to 15 in in diameter, use the same number of points as Turacre plots.
- For reliable estimates, never use fewer than 20 points in natural timber stands or less than 10 points in even-aged plantations.

10-19 Point samples versus plots. Of the numerous field comparisons of point sampling and plot cruising, one of the more extensive evaluations was made by the U.S. Forest Survey in Southeast Texas (Grosenbaugh

and Stover, 1957). In this test, BAF 10 point samples were measured throughout 12 counties. Volume per acre comparisons were made for from the centers of 655 circular 1/4-acre plots that were distributed BA, cubic-foot volumes, and board-foot volumes.

mated that 20 per cent more point samples would be needed to provide even with these additional samples the points could be measured in Differences in mean volumes by the two sampling methods were not significant at the 5 per cent level. Coefficients of variation for point sampling were only 7 to 12 per cent larger than for the 1/4-acre plots, and standard errors were within 0.5 per cent of each other. It was estithe same accuracy in cubic volume as derived from the plots; however, considerably less field time. Attributes and limitations. In summary, the principal advantages of point sampling over plot cruising are:

- 1 It is not necessary to establish a fixed plot boundary; thus greater cruising speed is possible.
- Large, high-value trees are sampled in greater proportions than smaller stems. BA and volume per acre may be derived without direct measurement of
  - stem diameters.
- efficient volume determinations can be made in a minimum of time. Thus When volume per acre conversions are developed in advance of fieldwork, the method is particularly suited to quick, reconnaissance-type emises.

## The main drawbacks to point sampling are:

- Heavy underbrush reduces sighting visibility and cruising efficiency.
- Because of the relatively small size of sampling units, carelessness and errors in the tally (when expanded to tract totals) are likely to be more serious than in plot cruising.
- Slope compensation causes difficulties that may result in large errors unless special care is exercised. Similar difficulties are encountered in strip and lineplot cruising, of course.
- Some problems arise in edge-effect bias when sampling very small tracts

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### **WOODY PLANTS**

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20
       Abies balsamea. Balsam fir.
23
       Aesculus spp. Aesculus.
24
       Aesculus Hippocastanum. Horsechestnut.
25
       Aesculus octandra. Sweet Buckeye.
28
       Acer spp. Maple.
       Acer negundo. Box Elder.
29
30
       Acer nigrum. Black maple.
31
       Acer pensylvanicum. Striped maple.
       Acer platanoides. Norway maple.
32
33
       Acer rubrum. Red maple.
34
       Acer saccharinum. Silver maple.
35
       Acer saccharum. Sugar maple.
36
       Acer spicatum. Mountain maple (Mtn. maple).
39
       Ailanthus altissima. Ailanthus, Tree of heaven.
42
       Akebia quinata. Akebia.
45
       Albizzia julibrissin. Mimosa.
48
       Alnus spp. Alder.
49
       Alnus maritima. Seaside alder.
50
       Alnus rugosa. Speckled alder.
51
       Alnus serrulata. Smooth alder.
52
       Althaea officinalis. Marshmallow.
54
       Amelanchier spp. Service Berry.
55
       Amelanchier arborea. Common Service Berry (Com. sycherry).
56
       Amelanchier canadensis. Canadian Service Berry (Can. svcberry).
57
       Amelanchier humilis. Low Service Berry (Lo. sycherry).
58
       Amelanchier intermedia spach. Intermediate Service Berry (Int. svcberry).
59
       Amelanchier laevis. Smooth Service Berry (Smith sycberry).
60
       Amelanchier obovalis. Obovate Service Berry (Obvt. svcberry).
61
       Amelanchier sanguinea. Roundleaf Service Berry (Rd. 1f. svcberry).
62
       Amelanchier stolonifera. Stoloniferous Service Berry (Stol. sycberry).
65
       Amorpha fruticosa. Falso indigo.
68
       Ampelopsis arborea. Pepper-vine.
69
       Aralia sp. L. Aralia.
71
       Aralia spinosa. Hercules Club.
74
       Aristolochia durior. Pipe-vine.
77
       Arundinaria gigantea. Brake cane.
80
       Ascyrum spp. Ascyrum.
       Ascyrum stans. St. Peter's wort. (St. Pete wort).
81
82
       Ascyrum hypericoides. St. Andrew's Cross. (St. Andy Cross).
85
       Asimina triloba. Pawpaw.
88
       Baccharis halimifolia. High-tide bush.
91
       Berberis spp. Barberry.
92
       Berberis canadensis. American Barberry (Amer. Barberry).
93
       Berberis thumbergii. Japanese Barberry (Jap. Barberry).
       Berberis vulgaris. Common Barberry (Com. Barberry).
94
95
       Berchemia scandens. Rattan-vine.
97
      Betula spp. Birch.
      Betula alba. European white birch (Eur. white birch).
98
99
      Betula lenta. Black birch.
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Betula lutea. Yellow birch.

100

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101
        Betula nigra. River birch.
104
        Bignonia capreolata. Crossvine.
107
        Broussonetia papyrifera. Paper Mulberry.
        Callicarpa americana. Beauty berry.
110
113
        Calycanthus floridus. Carolina allspice (Carol. allspice).
116
        Campsis radicans. Trumpet creeper (Trumpt, creepr.).
        Carpinus caroliniana. American hornbeam (Amer. hornbeam).
119
122
        Carya spp. Hickory.
123
        Carya cordiformis. Swamp hickory.
124
        Carya glabra. Pignut.
125
        Carya ovalis. Sweet pignut.
126
        Carya ovata. Shagbark Hickory (Shagbark).
127
        Carya pallida. Pale hickory.
128
        Carya tomentosa. Mockernut.
131
        Castanea spp. Castanea.
132
        Castanea dentata. American Chestnut (Amer. Chestnut).
133
        Castanea pumila. Chinquapin.
136
        Catalpa spp. Catalpa.
137
        Catalpa bignonioides. Southern catalpa (S. Catalpa).
138
        Catalpa ovata. Chinese Catalpa (Chinese Cat.).
139
        Catalpa speciosa. Northern Catalpa (N. Catalpa).
142
        Ceanothus americanus. New Jersey Tea (Jersey Tea).
145
        Celtis spp. Celtis.
146
        Celtis occidentalis. Hackberry.
        Celtis tenuifolia. Dwarf Hackberry (Dwf. Hackberry).
147
150
        Cephalanthus occidentalis. Buttonbush.
153
        Celastrus scandens. Bittersweet.
156
        Cercis canadensis. Redbud.
159
        Chamaecyparis thyoides. Southern White Cedar (S. White Cedar).
160
        Chamaedaphne calyculata. Leatherleaf.
162
        Chimaphila spp. Chimaphila.
163
        Chimaphila maculata. Spotted Wintergreen (Spot wintergrn.).
164
        Chimaphila umbellata. Pipsissewa.
167
        Chionanthus virginicus. Fringe-tree.
170
        Clematis spp. Clematis.
171
        Clematis dioscoreifolia. Clematis.
172
        Clematis verticillaris. Mountain clematis (Mtn. clematis).
173
        Clematis Viorna. Leather flower.
174
        Clematis virginiana. Virgin's bower.
177
        Clethra alnifolia. Sweet Pepperbush (Swt. Pepperbush).
180
        Comptonia peregrina. Sweet fern.
183
        Cornus alternifolia.
                              Green Osier.
184
        Cornus spp. Dogwood.
185
        Cornus Amomum. Red Willow.
186
        Cornus canadensis. Bunchberry.
187
        Cornus florida. Flowering dogwood (Flr. dogwood).
188
        Cornus obliqua. Silky dogwood.
        Cornus racemosa. Gray-stem dogwood (Gry.-stem dogwd.).
189
190
        Cornus stolonifera. Red Osier.
191
        Cornus rugosa. Roundleaf dogwood. (Rndleg. dogwood).
193
        Corylus spp. Hazel.
194
        Corylus americana. American hazelnut (Amer. hazelnut).
        Corylus cornuta. Beaked hazelnut (Beak. hazelnut).
195
        Crataegus spp. Hawthorn.
198
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199
        Crataegus basilica. Hawthorn #1.
200
        Crataegus biltmoreana. Biltmore Hawthorn (Biltmore Hthn.).
201
        Crataegus Calpodendron. Pear Hawthorn.
202
        Crataegus Canbyi. Canby's Hawthorn (Canby's Hthn.).
203
        Crataegus crus-galli. Cockspur-Thorn.
        Crataegus Dodgei. Dodge Hawthorn (Dodge Hthn.).
204
205
        Crataegus intricata. Hawthorn #2.
206
        Crataegus macrosperma. Variable Hawthorn (Var. Hawthorn).
207
        Crataegus Margaretta. Margaret Hawthorn (Margaret Hthn.).
208
        Crataegus mercerensis. Hawthorn #3.
209
        Crataegus pedicellata. Scarlet Hawthorn (Scarlet Hthn.).
        Crataegus pensylvanica. Hawthorn #4.
210
211
        Crataegus Phaenopyrum. Washington Hawthorn (Wash. Hawthorn).
212
        Crataegus populnea. Hawthorn #5.
213
        Crataegus pruinosa. Wax-fruit Hawthorn (Wax-fruit Hthn.).
214
        Crataegus punctata. Dotted Hawthorn (Dotted Hthn.).
215
        Crataegus rugosa. Hawthorn #6.
        Crataegus sicca. Hawthorn #7.
216
217
        Crataegus stolonifera. Hawthorn #8.
218
        Crataegus uniflora. Dwarf Hawthorn (Dwf. Hawthorn).
219
        Crataegus viridis. Southern Thorn (S. Thorn).
222
        Cytisus scoparius. Scotch Broom.
224
        Decodon verticillatus. Swamp loosestrife.
225
        Diervilla Lonicera. Bush Honeysuckle (Bsh. Honeysuckle).
228
        Diospyros virginiana. Common Persimmon (Com. Persimmon).
231
        Dirca Palustris. Leatherwood.
234
        Elaeagnus angustifolia. Russian olive.
237
        Epigaea repens. Ground laurel.
240
        Euonymus spp. Euonymus.
241
        Euonymus alatus. Winged Euonymus (Wing. Euonymus).
242
        Euonymus americanus. Strawberry Bush.
243
        Euonymus atropurpureus. Burning Bush.
246
        Fagus grandifolia. American Beech.
247
        Fagus sylvatica. European Beech.
249
        Forsythia spp. Forsythia.
250
        Forsythia suspensa. Forsythia.
251
        Forsythia viridissima. Forsythia.
254
        Fraxinus spp. Ash.
255
        Fraxinus americana. White Ash.
256
        Fraxinus pennsylvanica. Green Ash.
257
        Fraxinus nigra. Black Ash.
260
        Gaultheria procumbens. Wintergreen.
263
       Gaylussacia spp. Huckleberry.
       Gaylussacia baccata. Black huckleberry (Blk. hucklebry.).
264
      Gaylussacia brachycera. Juniper Berry.
265
266
       Gaylussacia dumosa. Dwarf huckleberry (Dwf. Hucklebry.).
267
        Gaylussacia frondosa. Dangleberry.
270
       Gleditsia triacanthos. Honey Locust.
273
       Gymnocladus dioica. Kentucky Coffeetree (Ky. Coffeetree).
276
       Hamamelis virginiana. Witch-hazel.
279
       Hedera Helix. English Ivy.
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281
        Hibiscus spp. Mallow.
282
        Hibiscus syriacus. Rose-of-Sharon.
285
        Hudsonia tomentosa. Beach heath.
288
        Hydrangea arborescens. Wild hydrangea.
291
        Hypericum spp. St. John's-wort.
292
        Hypericum densifolorum. St. John's-wort. (St. John-wort).
293
        Hypericum spathulatum. St. John's-wort. (St. John-wort).
295
        Ilex coreacea. Large Gallberry (Large Balberry).
296
        Ilex spp. Holly.
297
        Ilex decidua. Possum Haw.
298
        Ilex glabra. Inkberry.
299
        Ilex laevigata. Winterberry.
300
        Ilex montana. Mountain holly (Mtn. Holly).
301
        Ilex opaca. American Holly (Amer. Holly).
302
        Ilex verticillata. Black Alder.
305
        Itea virginica. Tassel-white.
308
        Iva frutescens. Low-tide bush.
311
        Juglans spp. Juglans.
312
        Juglans cinerea. Butternut.
313
        Juglans nigra. Black walnut.
316
        Juniperus communis. Common juniper.
317
        Juniperus virginiana. Red cedar.
320
        Kalmia spp. Laurel.
321
        Kalmia angustifolia. Sheep-laurel.
322
        Kalmia latifolia. Mountain laurel. (Mtn. laurel).
325
        Koelreuteria paniculata. Goldenrain-Tree (Goldenrn.-Tree).
326
        Kosteletzkya virginica. Seashore-mallow.
328
        Larix laricina. American larch.
331
        Leucothoe racemosa. Fetterbush.
334
        Ligustrum spp. Privet.
335
        Ligustrum obtusifolium. Privet.
336
        Ligustrum ovalifolium. California Privet (Cal. Privet).
337
        Ligustrum vulgare. Common privet.
        Lindera Benzoin. Blume Spicebush. (Blume Spicebsh.).
340
343
        Linnaea borealis. Twinflower.
346
        Liquidambar styraciflua. Sweet gum.
349
        Liriodendron tulipifera. Tulip tree.
352
        Lonicera spp. Honeysuckle.
353
        Lonicera canadensis. Fly-honeysuckle (Fly-honeysukl.).
354
        Lonicera dioica. Mountain honeysuckle (Mtn. honysukl.).
355
        Lonicera japonica. Japanese honeysuckle (Jap. honeysukl.).
356
        Lonicera Morrowi. Honeysuckle #1.
357
        Lonicera sempervirens. Trumpet honeysuckle (Trump. hnysukl.).
358
        Lonicera tatarica. Tartarian honeysuckle (Tarta. hnysukl.).
361
        Lycium halimifolium. Matrimony vine.
364
        Lyonia spp. Lyonia.
365
        Lyonia ligustrina. Male-berry.
366
        Lyonia mariana. Stagger bush.
369
       Maclura pomifera. Osage orange.
372
       Magnolia spp. Magnolia.
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373
         Magnolia acuminata. Cucumber tree.
374
         Magnolia tripetala. Umbrella Magnolia (Umbrella Mag.).
375
        Magnolia virginiana. Sweet Bay.
378
        Menisperum canadense. Canadian Moonseed (Can. Moonseed).
381
         Menziesia pilosa. Minnie-bush.
384
        Mitchella repens. Partridge berry (Partridge bry.).
387
        Morus spp. Mulberry.
388
        Morus alba. White Mulberry.
        Morus rubra. Red Mulberry.
389
 392
        Myrica spp. Myrica.
393
        Myrica cerifera. Wax-myrtle.
394
        Myrica pensylvanica. Bayberry.
397
         Nemopanthus mucronata. Catherry, Mountain Holly.
400
         Nyssa sylvatica. Black gum.
401
         Opuntia humifusa. Prickly pear.
403
         Ostrya virginiana. Hop Hornbeam.
406
         Oxydendrum arboreum. Sorrel Tree.
409
         Parthenocissus quinquefolia. Virginia Creeper (Va. Creeper).
412
         Paulownia tomentosa. Empress tree.
415
         Persea Borbonia. Red Bay.
418
         Philadelphus spp. Mock Orange.
419
         Philadelphus coronarius. Garden Mock-orange (Gdn. Mock-orng.).
420
         Philadelphus hirsutus. Hairy Mock-orange (Hry. Mock-orng.).
         Philadelphus inodorus. Common Mock-orange (Com. Mock-orng.).
421
422
         Philadelphus pubescens. Gray Mock-orange (Gry. Mock-orng.).
        Phoradendron flavescens. Mistletoe.
425
428
         Physocarpus opulifolius. Ninebark.
431
         Picea spp. Spruce.
432
         Picea Abies. Norway Spruce.
433
         Picea glauca. White Spruce.
434
         Picea pungens. Blue Spruce.
         Picea rubens. Red Spruce.
435
438
         Pinus spp. Pine.
         Pinus echinata. Yellow Pine.
439
440
         Pinus resinosa. Red Pine.
 441
         Pinus rigida. Pitch Pine.
 442
         Pinus serotina. Marsh Pine, Pond Pine.
         Pinus strobus. White Pine.
443
444
         Pinus sylvestris. Scotch Pine.
445
         Pinus taeda. Loblolly Pine.
446
         Pinus virginiana. Virginia Pine.
447
         Pinus nigra. Austrian Pine.
449
         Platanus occidentalis. Sycamore.
452
         Populus spp. Populus.
         Populus alba. White poplar.
453
        Populus canescens. Gray poplar.
Populus deltoides. Eastern cottonwood (E. cottonwood).
454
455
456
         Populus gileadensis. Balm of Gilead (Gilead Balm).
457
         Populus grandidentata. Large-toothed aspen (lg. tooth aspen).
 458
         Populus heterophylla. Downy poplar.
459
         Populus nigra. Black poplar.
460
         Populus tremuloides. Trembling aspen.
461
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Potentilla spp. Cinquefoil.

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5 4 1 8 8 4 A
        Prunus spp. Prunus.
463
        Prunus alleghaniensis. Allegheny Plum (Allgny. Plum).
464
465
        Prunus americana. American Wild Plum (A. Wild Plum).
466
        Prunus angustifolia. Chickasaw Plum.
467
        Prunus avium. Bird Cherry.
468
        Prunus Cerasus. Sour Cherry.
        Prunus Mahaleb. Mahaleb Cherry.
469
470
        Prunus maritima. Beach Plum.
471
        Prunus pensylvanica. Pin Cherry.
472
        Prunus Persica. Peach.
473
        Prunus serotina. Black Cherry.
474
        Prunus virginiana. Choke Cherry.
477
        Ptelea trifoliata. Water-ash.
480
        Pyrus spp. Pyrus.
481
        Pyrus americana. American mountain ash (Am. mtn. ash).
.482.
        Pyrus angustifolia Ait. Wild crab.
        Pyrus arbutifolia. Red chokeberry.
483
484
        Pyrus communis. Common pear.
485
        Pyrus coronaria. Wild crab.
486
        Pyrus floribunda. Purple chokeberry (Pur. chokeberry).
487
       Pyrus Malus. Apple.
488
        Pyrus melanocarpa. Black chokeberry (Blk. chokeberry).
491
        Quercus spp. Oak.
492
        Quercus alba. White oak.
493
        Quercus bicolar. Swamp white oak.
494
        Quercus coccinea. Scarlet oak.
495
        Quercus falcata. Southern red oak (S. red oak).
496
        Quercus ilicifolia. Scrub oak.
497
        Quercus imbricaria. Shingle oak.
498
        Quercus lyrata. Swamp post oak.
499
        Quercus macrocarpa. Bur oak.
500
        Quercus marilandica. Black Jack oak.
501
        Quercus Michauxii. Basket oak, Swamp Chestnut Oak.
502
        Quercus Muehlenbergii. Yellow oak.
503
        Quercus nigra. Water oak.
504
        Quercus palustris. Pin Oak.
505
        Quercus Phellos. Willow oak.
506
        Quercus prinoides. Chinquapin oak.
507
        Quercus Prinus. Chestnut oak, Rock oak.
508
        Quercus rubra. Red oak.
509
        Quercus Shumardii. Shumard's oak.
510
        Quercus stellata. Post oak.
        Quercus velutina. Black oak.
511
512
        Quercus laurifolia. Laurel-leaved oak.
514
        Rhamnus spp. Buckthorn.
515
        Rhamnus cathartica. Common Buckthorn (Com. Buckthorn).
516.
        Rhamnus frangula. European Buckthorn (Eur. Buckthorn).
519
        Rhododendron spp. Rhododendron.
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520
        Rhododendron arborescens. Smooth Azalea.
521
        Rhododendron atlanticum. Dwarf Azalea.
522
        Rhododendron calendulaceum. Flame Azalea.
523
        Rhododendron canescens. Sweet Azalea.
524
        Rhododendron maximum. Rosebay.
525
        Rhododendron nudiflorum. Pink Azalea.
526
        Rhododendron roseum. Mountain Azalea (Mtn. azalea).
        Rhododendron viscosum. Swamp Azalea.
527
529
        Rhus spp. Rhus.
530
        Rhus aromatica. Fragrant Sumac.
531
        Rhus copallina. Shining Sumac.
532
        Rhus glabra. Smooth Sumac.
533
        Rhus radicans. Poison Ivy.
534
        Rhus toxicodendron. Poison Oak.
535
        Rhus typhina. Staghorn Sumac.
536
        Rhus vernix. Poison Sumac.
539
        Ribes spp. Ribes.
540
        Ribes americanum. Black Currant.
        Ribes cynosbati. Dogberry.
541
542
        Ribes glandulosum. Skunk Currant.
543
        Ribes rotundifolium. Eastern Wild Gooseberry (E. gooseberry).
.546
        Robinia spp. Locust.
547
        Robinia hispida. Bristly Locust.
548
        Robinia pseudo-acacia. Black Locust.
551
        Rosa spp. Rose.
552
        Rosa canina. Dog Rose.
        Rosa carolina. Low Pasture Rose (L. pasture rose).
553
        Rosa eglanteria. Sweet Brier.
554
        Rosa multiflora. Multiflora Rose (Multiflr. rose).
555
        Rosa palustirs. Swamp Rose.
556
        Rosa virginiana. Pasture Rose.
557
560
        Rubus spp. Raspberry.
561
        Rubus argutus. Tall Blackberry (Tall bkberry).
562
        Rubus allegheniensis. Allegheny Blackberry (Allgny bkberry).
563
        Rubus cuneifolius. Sand Blackberry (Sand bkberry).
564
        Rubus eusleuii. Southern Dewberry (S. dewberry).
565
        Rubus flagellaris. Northern Dewberry (N. dewberry).
566
        Rubus hispidus. Swamp Dewberry.
567
        Rubus occidentalis. Wild Black Raspberry (Blk. raspberry).
568
        Rubus odoratus. Purple-Flowering Raspberry.
569
        Rubus ostryifolius. Dewberry.
        Rubus pensilvanicus. Blackberry #1.
570
        Rubus phoenicolasius. Wineberry.
571
572
        Rubus ideas strigosus. Maximum Red Raspberry (Max. red rsberry).
575
        Salix spp. Willow.
576
        Salix alba. White Willow.
577
        Salix babylonica. Weeping Willow.
578
        Salix bebbiana. Bebb's Willow.
579
        Salix capra. Goat Willow.
580
        Salix caroliniana. Ward's Willow.
581
        Salix, discolor. Pussy Willow.
582
        Salix fragilis. Crack Willow.
.583
        Salix hispida. Bristly Crier.
        Salix humilis. Upland Willow.
584
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585
         Salix interior. Sandbar willow.
586
         Salix lucida. Shining willow.
         Salix nigra. Black willow.
587
588
         Salix pentandra. Bay-leaf willow (Bay-lf. willow).
589
         Salix purpurea. Purple willow.
590
         Salix rigida. Heart-leaf willow (Heart-lf. willow).
591
         Salix sericea. Silky willow.
594
         Sambucus spp. Elder.
         Sambucus canadensis. Common elder.
595
596
         Sambucus pubens. Red-berry Elder (Red-bry. Elder).
599
         Sassafras albidum. White Sassafras (Wt. Sassafras).
602
         Smilax spp. Smilax.
603
         Smilax Bona-nox. Bullbrier.
604
         Smilax glauca. Sawbrier.
605
         Smilax laurifolia. Laurel-leaf brier (Laurl.-lf. brier).
606
         Smilax rotundifolia. Common greenbrier (Com. greenbrier).
607
         Smilax walterei. Redberried Greenbrier.
         Solanum spp. Nightshade.
608
609
         Solanum Dulcamara. Bittersweet.
612
         Spiraea spp. Spiraea.
613
         Spiraea alba. Narrow-leaved Meadow Sweet (Nr.-1v. Md.-Sweet).
614
         Spiraea corymbosa. Corymed Spiraea.
615
         Spiraea japonica. Japanese spiraea (Jap. spiraea).
         Spiraea latifolia. American Meadow Sweet (Am. Md.-Sweet).
616
         Spiraea tomentosa. Steeple-bush.
617
620
         Staphylea trifolia. American bladdernut (A. bladdernut).
621
         Styrax grandifolia. Storax.
623
         Symphoricarpos spp. Symphoricarpos.
624
         Symphoricarpos alba. Snowberry.
625
         Symphoricarpos orbiculatus. Coralberry.
628
         Symplocos tinctoria. Horse-sugar.
631
         Syringa spp. Lilac.
632
         Syringa Persica. Persian lilac.
633
         Syringa vulgaris. Lilac.
636
         Taxodium distichum. Baldcypress.
639
         Thuja occidentalis. N. white cedar.
         Tilia spp. Basswood.
642
643
         Tilia americana. Basswood.
644
         Tilia heterophylla. White Basswood.
647
         Tsuga canadensis. Hemlock.
650
         Ulmus spp. Elm.
         Ulmus americana. American elm.
651
652
        Ulmus parvifolia. Chinese elm.
653
         Ulmus procera. English elm.
654
         Ulmus pumila. Siberian elm.
655
        Ulmus rubra. Red elm.
658
        Vaccinium spp. Vaccinium.
659
         Vaccinium angustifolium. Low sweet blueberry (Lo. swt. blubry.).
660
         Vaccinium atrococcum. Black High-bush blueberry (Bk. hi.-bsh. bbry.).
661
        Vaccinium caesariense. Jersey blueberry (Jsy. blubry.).
662
        Vaccinium corymbosum. High-bush blueberry (hi.-bsh.-blubry.).
663
        Vaccinium macrocarpon. American cranberry (A. cranberry).
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664
         Vaccinium myrtilloides.
                                  Canadian Blueberry (Can. Blueberry).
665
         Vaccinium Oxycoccos. Small cranberry (Sml. cranberry).
666
         Vaccinium stamineum.
                               Deerberry.
667
        Vaccinium vacillans. Low blueberry.
670
         Viburnum spp. Viburnum.
         Viburnum acerifolium. Maple-leaved viburnum (Maple-lv. vib.).
671
672
         Viburnum alnifolium. Hobblebush.
         Viburnum cassinoides. Witherod.
673
674
         Viburnum dentatum. Southern Arrow-wood (S. Arrow-wood).
675
         Viburnum Lentago. Nannyberry.
676
         Viburnum nudum. Possum-haw.
677
         Viburnum prunifolium. Black-haw.
678
         Viburnum Rafinesquianum. Downy Arrow-wood (Downy Arrow-wd.).
         Viburnum recognitum. Smooth Arrow-wood (Smth. Arrow-wd.).
679
680
         Viburnum rufidulum. Rusty black-haw.
         Viburnum molle. Soft-leaved Arrow-wood (Sft. Lvd. Arrow-wd.).
681
682
         Vitex Agnus-castus. Chaste tree.
         Vitis spp. Grape.
685
686
         Vitis aestivalis. Summer grape.
687
         Vitis Labrusca. Fox grape.
688
         Vitis riparia. Frost grape.
689
         Vitis rotundifolia. Muscadine grape (Muscadine grp.).
690
         Vitis rupestris. Sugar grape.
691
         Vitis vulpina. Winter grape.
694
         Wisteria spp. Wisteria.
         Wisteria floribunda. Wisteria #1.
695
696
         Wisteria frutescens. Wisteria #2.
697
         Wisteria sinensis. Sweet Wisteria.
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### Sources:

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### HERBACEOUS PLANTS

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2000
          Acalypha virginica. Three-seeded Mercury.
2003
          Achillea millefolium. Common Yarrow.
2006
          Acnida cannabina. Water-Hemp.
2009
          Acorus calamus. Sweet Flag.
2012
          Actinomeris alternifolia. Wingstem.
2013
          Adiantum pedatum. Maidenhair Fern.
2015
          Aeschynomene spp. Sensitive Joint Vetch.
2018
          Agastache nepetoides. Purple Giant Hyssop.
2021
          Agrimonia spp. Cocklebur.
2024
          Agropyron spp. Couch Grass #1.
2027
          Agropyron repens. Couch Grass #2.
2030
          Agrostis spp. Agrostis.
2033
          Agrostis hyemalis. Rough Hair Grass (Rg Hair Grass).
2036
          Alisma spp. Water Plantain #1 (Watr Plantan 1).
2039
          Alisma plantago-aquatica. Water Plantain #2 (Watr Plantan 2).
2042
          Allium spp. Garlic.
2045
          Amaranthus spp. Amaranth.
2048
          Ambrosia spp. Ragweed.
2051
          Amianthium Muscaetoxicum. Fly-Poison.
2054
          Ammophila arenaria. Sand Reed.
2057
          Amphicarpa bracteata. Hog-Peanut.
2060
          Anagallis arvensis. Scarlet Pimpernel.
2063
          Andropogon spp. Beard Grass.
2066
          Andropogon geradi. Forked Beard-Grass (Frk Berd Grass).
2069
          Andropogon scoparius. Little Blue-Stem (Ltl Blue Stem).
          Andropogon ternarius. Silvery Beard-Grass (Slv Berd Grass).
2072
2075
          Andropogon virginicus. Broom-Sedge (Va Beard Grass).
2078
          Anemone spp. Anemone.
2081
          Anemonella thalictroides. Rue-Anemone.
2084
          Antennaria spp. Everlasting.
2087
          Anthemis spp. Chamomile.
2090
          Anthoxanthum spp. Vernal Grass #1.
2093
          Anthoxanthum odoratum. Vernal Grass #2.
2096
          Apios americana. Groundnut.
2099
          Aplectrum hyemale. Putty-Root.
2102
          Apocynum spp. Dogbane.
2105
          Aquilegia spp. Columbine.
2108
          Arabidopsis thabana. Mouse-Ear-Cress.
2111
          Arabis spp. Rock-Cress.
2113
          Arctium spp. Burdock.
          Arisaema sp. Jack-in-the-Pulpit (Jk-n-th-plpit).
2115
2117
          Arisaema triphyllum. Jack-in-the-Pulpit (Jck-n-th-plpit).
2119
          Aristida spp. Three-Awn.
2121
          Aristida dichtoma. Poverty Grass.
2123
          Asclepias spp. Milkweed.
2125
          Asparagus officinalis. Asparagus.
2127
          Asplenium platyneuron. Ebony Spleenwort (Ebony Splnwort).
          Aster spp. Wild Aster.
2129
          Athyrium felix-femina. Lady Fern.
2131
          Athyrium Thelypteroides. Crested Fern.
2133
          Atriplex spp. Orach.
2134
          Baptisia spp. False Indigo.
2137
          Barbaria spp. Winter-Cress.
2140
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2143
          Bidens spp. Beggars Tick.
2146
          Boehmeria cylindrica. False Nettle.
2149
          Botrychium dissectum. Grape Fern.
2152
          Botrychium virginianum. Virginia Grape Fern (Va Grape Fern).
2155
          Brasenia schreberi. Water-Shield.
2158
          Bromus spp. Brome-Grass.
2161
          Bulbostylis capillaris. Bulbostylis.
2164
          Cahile edentula. Sea-Rocket.
2167
          Callitriche spp. Water Starwart.
2170
          Calopogon pulchellus. Grass-Pink.
2173
          Capsella bursa-pastoris. Shepherd's-Purse.
2176
          Cardamine spp. Bitter Cress.
2179
          Carex spp. Carex.
2182
          Cassia spp. Senna.
2185
          Cenchrus tribuloides. Bur-Grass.
2188
          Centaurea spp. Star-Thistle.
2191
          Cerastium spp. Mouse-Ear-Chickweed.
          Ceratophyllum spp. Coontail.
2194
2197
          Chamaelirium spp. Blazing Star #1.
2200
          Chamaelirium luteum. Blazing Star #2.
2203
          Chelone spp. Turtlehead.
2204
          Chelone lyoni. Red Turtlehead.
2206
          Chenopodium spp. Pigweed.
2209
          Chimaphila maculata. Spotted Wintergreen. (Spottd Wintrgrn).
2212
          Chrysopsis spp. Golden Aster.
2215
          Cichorium intybus. Chicory.
2216
          Cicuta maculata. Water Hemlock.
2218
          Cinna spp. Wood Reedgrass.
2221
          Circaea quadrisulcata. Enchanters Nightshade (Ench Nitshade).
2224
          Cirsium spp. Common Thistle.
2227
          Cladium mariscoides. Twig Rush.
2230
          Claytonia spp. Spring-Beauty.
          Collinsonia canadensis. Horse-Balm.
2233
2236
          Comandra umbellata. Bastard-Toadflax.
2239
          Commelina spp. Day Flower.
2242
          Convolvulus spp. Bindweed.
2245
          Corallorhiza spp. Coral-Root.
2248
          Coreopsis spp. Tickseed.
2251
          Croton spp. Croton.
2254
          Cryptotaenia canadensis. Honewort.
2257
          Cuscuta spp. Dodder.
2260
          Cynoglossum spp. Wild Comfrey.
2263
          Cyperus spp. Cyperus.
2266
          Cypripedium spp. Ladies Slipper.
          Cypripedium acaule. Moccasin Flower (Mocasin Flwr).
2269
2272
          Danthonia spp. Wild Oat-Grass.
2275
          Daucus Carota. Wild Carrot.
          Datura spp. Jimson Weed.
2278
          Dennstaedtia punctilobula. Hayscent Fern.
2280
2281
          Dentaria spp. Toothwort.
2284
          Deschampsia spp. Hairgrass.
2287
          Desmodium spp. Ticl-trefoil.
2290
          Dianthus spp. Pink.
2293
          Digitaria spp. Finger Grass #1.
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2546

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2296
          Disitaria ischaemum. Small Crab Grass.
2299
          Digitaria sanguinalis. Finger Grass #2.
2302
          Diodia teres. Buttonweed.
2305
          Dioscorea spp. Yam.
2309
          Distichlis spicata. Marsh Spike Grass (Mrsh Spk Grass).
2411
          Draba spp. Draba.
2414
          Drosera spp. Sundew.
2417
          Dryopteris spp. Wood Fern.
2420
          Dryopteris cristata. Crested Wood Fern.
2423
          Dryopteris hexagonoptera. Broad Beech Fern.
2426
          Dryopteris marginalis. Marginal Shield Fern (Margn Sld Fern).
2429
          Dryopteris noveboracensis. New York Fern.
2432
          Dryopteris phegoptaris. Long Beech Fern.
2435
          Dryopteris spinulosa. Spinulose Wood Fern.
2438
          Dryopteris thelypteris. Marsh Fern.
2440
          Duchesnea indica. Ind. Strawberry.
2441
          Dulichium arundinaceum. Dulichium.
2444
          Echinochloa spp. Echinochloa.
2447
          Eleocharis spp. Spike Rush.
2450
          Elephantopus spp. Elephant's Foot.
2453
          Elodea spp. Waterweed.
2456
          Elodea canadensis. Waterweed.
2459
          Elymus spp. Wild Rye.
2462
          Epifagus virginiana. Beechdrops.
2465
          Epilobium spp. Willow Herb.
2468
          Equisetum spp. Horsetail.
2471
          Equisetum arvense. Field Horsetail (Field Horsetl).
2474
          Equisetum hyemale. Scouring-Rush.
2477
          Eragrostis spp. Love Grass.
2480
          Erechtites spp. Fireweed.
2483
          Erianthus spp. Plume Grass #1.
2486
          Erianthus giganteus. Plume Grass #2.
2489
          Erigeron spp. Fleabane.
2492
          Eriocaulon spp. Pipewort #1.
2495
          Eriocaulon septangulare. Pipewort #2.
2498
          Eriophorum spp. Cotton-Grass.
          Eriophorum virginicum. Virginia Cotton-Grass (Va Coton Grass).
2501
2504
          Erythronium spp. Adder's Tongue.
2507 -
          Eupatorium spp. Joe Pyeweed.
2508
          Eupatorium Perfoliatum. Boneset.
2510
          Euphorbia spp. Spurge.
2513
          Festuca spp. Fescue.
2516
          Fimbristylis spp. Fimbristylis.
2519
          Fragaria spp. Strawberry.
2522
          Froelichia spp. Cottonweed.
2525
          Fuirena spp. Fuirena.
2528
          Galium spp. Bedstraw.
2531
          Gentiana spp. Gentian.
2534
          Geranium spp. Cranesbill.
          Gerardia spp. Gerardia.
2537
          Geum spp. Geum.
2540
2541
          Glechoma Hederacea. Ground Ivy.
          Glyceria spp. Manna Grass.
2543
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Gnaphalium spp. Cudweed.

2699

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2549
          Gonolobus spp. Angle-Pod.
2552
          Goodyera pubescens. Rattlesnake Plaintain (Ratlsnk Platn).
2555
          Gratiola spp. Hedge-Hyssop.
2558.
          Habenaria spp. Orchis.
2561
          Hackelia virginiana. Stickseed.
2564
          Helianthemum spp. Frostweed.
2567
          Helianthus spp. Sunflower.
2570
          Hemerocallis fulva. Day Lily.
2573
          Hepatica spp. Liverleaf.
2576
          Heteranthera spp. Mud Plantain.
2579
          Heteranthera dubia. Water Star Grass (Watr Star Gras).
2582.
          Hexalectus spicata. Crested Coral-Root.
2585
          Hieracium spp. Hawkweed.
2588
          Hordeum spp. Barley.
2591
          Houstonia spp. Star-Violet.
2594
          Hydrocotyle spp. Water-Pennywort.
2597
          Hypericum spp. St. John's Wort.
          Hypericum Virginicum. Marsh St. John's-Wort (Marsh St. Jns-Wt.)
2599:
2600
          Hypoxis hirsuta. Star Grass.
2603
          Hystrix patula. Bottle-Brush Grass (Botle-Brsh Grs).
2606
          Impatiens spp. Jewel-Weed.
2609
          Ipomoea spp. Morning Glory.
2612
          Iris spp. Iris.
          Iris versicolor. Large Blue-Flag (Lg. Blue-Flag).
2615
2618
          Isoetes saccharata. Quillwort.
2621
          Isotria verticillata. Whorled Pogonia.
2624
          Juncus spp. Bulrush.
2626
          Jussiaea repens. Primrose Willow.
2627
          Lactuca spp. Wild Lettuce.
2630
          Lamium spp. Dead-Nettle.
2633
          Laportea canadensis. Wood-Nettle.
          Lechea spp. Pinweed.
2636
2642
          Lemna minor. Duckweed.
2643
          Leontodon autumnalis. Fall Dandelion.
2645
          Lepidium spp. Pepperwort.
2648
          Lespedeza spp. Bush Clover.
2651
          Liatris spp. Button Snakeroot.
2654
          Lilaeopsis chinensis. Lilaeopsis.
2657
          Lilium spp. Red Lily.
2660
          Lilium canadense. Wild Yellow Lily (Wld Yelow Lily).
2663
          Limonium spp. Sea-Lavender.
2665
          Linaria canadensis. Toad-Flax.
2666
          Lindernia spp. False Pimpernel.
2669
          Linum spp. Flax.
2672
          Liparis lilifolia. Large Tway Blade (Lg Tway Blade).
2675
          Lobelia cardinalis. Cardinal Flower.
2678
          Lolium spp. Lolium.
2681
          Ludwigia spp. False-Loosestrife.
2684
          Ludwigia palustris. Water-Purslane.
2687
          Lugala spp. Woodrush.
2690
          Lychnis spp. Campion.
2693
          Lycopodium spp. Club-Moss.
2696
          Lycopodium complanatum. Crow-Foot.
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Lycopodium inundatum. Bog Club-Moss.

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2702
          Lycopodium lucidulum. Shining Club Moss.
2705
          Lycopodium obscurum. Ground Pine #1.
2708
          Lycopodium tristachyum. Ground Pine #2.
2711
          Lycopsis spp. Water Horehound.
2714
          Lygodium salmatum. Climbing Fern.
2717
          Lysimochia spp. Loosestrife.
2720
          Lythrum spp. Loosestrife.
2723
          Malaxis unifolia. Green Adders Mouth (Grn Aders Moth).
2736
          Malva spp. Mallow.
2739
          Medeola virginiana. Indian Cucumber-Root (Idn Cucumbr Rt).
2742
          Melampyrum lineare. Cow-Wheat.
2745
          Melanthium spp. Bunch Flower #1.
2748
          Melanthium lybridum. Crisped Bunch Flower (Crsp Bnch Flwr).
2751
          Melanthium virginicum. Bunch Flower #2 (Bunch Flowr #2).
2754
          Melilotus spp. Sweet Clover.
2757
          Mentha spp. Spearmint.
2760
          Mikania Scandens.
2763
          Mimulus spp. Monkey-Flower.
2764
          Mimulus ringens. Monkey-Flower.
2766
          Mollugo verticillata. Carpetweed.
2769
          Monarda spp. Horsemint.
2772
          Monotropa spp. Pine Sap.
2775
          Monotropsis odorata. Pygmy Pipes.
2778
          Muhlenbergia spp. Dropseed Grass.
2781
          Myosotis spp. Forget-Me-Not.
2784
          Myriophyllum spp. Water Mill Foil.
2787 -
          Myriophyllum spicatum. Eurasian Water Milfoil.
2790
          Najas spp. Naiad.
2793
          Najas flexilis. Pondweed.
2796
          Najas gracillima. Thread-like Najas (Thrd-lke-Najas).
2799
          Narcissus spp. Narcissus.
2802
          Nasturtium officinale. Watercress.
2805
          Nuphar spp. Water Lily (Wt Lily).
2808
          Nymphaea spp. Fragrant Water Lily (Frgnt Wt Lily).
2811
          Obolaria virginica. Pennywort.
2814
          Oenothera spp. Evening-Primrose.
2817
          Onoclea sensibilis. Sensitive Fern.
2820
          Ophioglossum spp. Adders Tongue #1 (Aders Tongue 1).
2823
          Ophioglossum vulgatum. Adders Tongue #2 (Aders Tongue 2).
2826
          Opuntia humifusa. Prickly Pear.
2829
          Orchis spectabilis. Showy Orchis.
2832
          Orontium aquaticum. Golden Club.
2835
          Osmorhiza spp. Sweet Cicly.
2838
          Osmunda cinnamomea. Cinnamon Fern.
2841
          Osmunda claytoniana. Interrupted Fern (Interupt Fern).
2844
          Osmunda regalis. Royal Fern.
2847
          Oxalis spp. Wood Sorrel.
2850
          Panicum spp. Panic Grass.
2853
          Panicum agrostoides. Red-Top Panic Grass (Nw-Lv Panic Gs).
2856
          Panicum capillare. Witch Grass.
2859
          Panicum dichotomum. Narrow Panicum (Nrw Panic).
2862
          Panicum microcarpon. Barbed Panic-Grass (Barb Panic Gs).
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2865
          Paspalum spp. Paspalum.
2868
          Paspalum floridanum. Florida Paspalum (Flord Paspalum).
2871
          Paspalum laeve. Field Paspalum.
2874
          Passiflora spp. Passion-Flower.
2877
          Pellaea spp. Cliff-Brake.
2880
          Peltandra virginica. Arrow-arum.
2883
          Penthorum sedoides. Ditch-Stonecrop.
2886 .
          Phalaris spp. Phalaris.
2889
          Phalaris arundinacea. Reed Canary Grass (Rd. Cnry Grass).
2892
          Phalaris canariensis. Canary Grass.
2895
          Phaseolus solystachios. Wild Bean.
2898
          Phleum pratense. Timothy.
2899
          Phlox maculata. Phlox.
2901
          Phragmites communis. Reed Grass.
2904
          Phryma leptostachya. Lopseed.
2907
          Physalis spp. Ground-Cherry.
2910
          Phytolacca americana. Pokeweed.
2913
          Pilea spp. Richweed.
2916
          Plantago spp. Plantain.
2919
          Pluchea spp. Stinkweed.
2922
          Poa spp. Poa.
2925
          Podophyllum peltatum. May Apple.
2928
          Podostemum ceratophyllum. Threadfoot.
2931
          Pogonia spp. Pogonia.
2932
          Pogonia ophioglossoides. Beard Flower.
2934
          Polygala spp. Milkwort.
2937
          Polygonatum biflorum. Solomons Seal.
2940
          Polygonum spp. Smartweed.
2943
          Polygonum arifolium. Halberd-Leaved Tearthumb.
2945
          Polygonum sagittatum. Arrow-Leaved Tearthumb (Arr-Lvd Trthmb).
2946
          Polygonumsceandens. False Climbing Buckwheat.
2949
          Polymnia uvedalia. Leaf-Cup.
2952
          Polypogon monspeliensis. Beard-Grass.
2955
          Polystichum acrostichoides. Christmas Fern.
2958
          Pontederia cordata. Pickerel-Weed.
2961
          Potamogeton spp. Pondweed #1.
2964
          Potamogeton crispus. Pondweed #2.
2967
          Potamogeton diversifolius. Pondweed #3.
2970
          Potamogeton nodosus. Pondweed #4.
2973
          Potamogeton mysticus. Pondweed #5.
2976
          Potamogeton natans. Pondweed #6.
2979
          Potamogeton epihydrus. Pondweed #7.
2982
          Potamogeton pectinatus. Pondweed #8.
2985
          Potamogeton perfoliatus. Pondweed #9.
2988
          Potamogeton pulcher. Pondweed #10.
2991
          Proserpinoca spp. Mermaidweed.
2994
          Prunella vulgaris. Heal-All.
2997
          Pteridium aquilinum. Bracken Fern.
3000
          Ptelimnium spp. Mock Bishop-s-Weed.
3003
          Pycnanthemum spp. Mountain-Mint.
3006
          Ranunculus spp. Buttercup.
3009
          Rhexia spp. Deergrass.
2912
          Rhynchospora spp. Beaked-Rush.
3015
          Rhynchospora alba. White Beaked-Rush (Wt Beakd-Rush).
3018
          Rhynchospora corniculata. Horned Rush.
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3021
          Rorippa spp. Yellow Cress.
3024
          Rorippa islandica. Yellow Cress.
3027
          Rudbeckia spp. Coniflower.
3030
          Rumex spp. Dock, Sorrel.
3033
          Ruppia maritima. Tassel Pondweed (Tasel Pondweed).
3036
          Sabatia spp. Sabatia.
3039
          Sagittaria spp. Arrow-Head #1.
3042
          Sagittaria engelmanniana. Arrow-Head #2.
3045
          Sagittaria graminea. Arrow-Head #3.
3048
          Sagittaria falcata. Lance-Leaved Arrow-Head (Lance Lv Ar Hd).
3051
          Sagittaria latifolia. Arrow-Head #4.
3054
          Sagittaria subulata. Arrow-Head #5.
3057
          Salicornia spp. Glasswort.
3060
          Salsola kali. Saltwort.
3063
          Salvia spp. Sage.
3066
          Samolus parviflorus. Water-Pimpernel.
3069
          Sanguinaria canadensis. Bloodroot.
3072
          Sanguisorba spp.
3075
          Sanicula spp. Black Snakeroot.
3078
          Sarracenia spp. Pitcher. Plant.
3091
          Satureja spp. Savory.
3094
          Saururus cernuus. Lizard Tail.
3097
          Saxifraga spp. Saxifrage.
3100
          Scirpus spp. Club-Rush.
3103
          Scleria spp. Nut Rush.
3106
          Sedum spp. Stonecrop.
3109
          Selaginella apoda. Selaginella.
3112
          Senicio spp. Squaw-Weed.
3115
          Seriocarpus asteroides. White-Topped Aster.
3118
          Setaria spp. Foxtail Grass.
3121
          Sicyos angulatus. Burr-Cucumber.
3124
          Silene spp. Catchfly.
3127
          Sisyrinchium spp. Blue-Eyed Grass (Blu-Eyed Grass).
3130
          Sisyrinchium angustifolium. Stout Blue-Eyed Grass (St Blu-Eyd Gras).
3133
          Sium suave. Water Parsnip.
3136
          Smilacina racemosa. False Solomon Seal (Fls Solmn Seal).
          Smilax pseudo-china. False China Root (Fls China-Root).
3137
3139
          Solidago spp. Goldenrod.
3142
          Sorgum halepense. Johnson-Grass.
3145
          Sparganium spp. Bur-Reed.
3148
          Spartina patens. Salt Meadow Grass.
3149
          Spartina cynosuroides. Salt-Reed Grass.
3151
          Sphagnum spp. Sphagnum.
3154
          Sphenopholis spp. Eatons Grass.
3157
          Spiranthes spp. Ladies-Tresses.
3160
          Spirodela polyrhiza. Greater Duckweed (Grt Duckweed).
3163
          Sporabolus spp. Rush-Grass.
3166
          Stellaria spp. Chickweed.
3169
          Strophostyles spp. Wild Bean.
3172
          Stylosanthes spp. Pencil Flower.
3175
          Symplocarpus foetidus. Skunk Cabbage.
3178
          Taraxacum spp. Dandelion.
3181
          Teucrium canadense. Wood-Sage.
3184
          Thalictrum spp. Meadow Rue.
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3187
          Tipularia discolor. Crane-Fly Orchis (Crn-Fly Orchis).
3190
          Tovara virginiana. Jumpseed.
3193
          Tradescantia virginiana. Spiderwort.
3194
          Trapa spp. Waterchestnut.
3196
          Trifolium spp. Clover.
3199
          Trillium spp. Wake-Robin.
3202
          Triosteum spp. Horse Gentian.
3205
          Triplasis purpurea. Sand-Grass.
3208
          Tripsacum dactyloides. Gama Grass.
3211
          Typha angustifolia. Narrow-Leaved Cat-Tail.
3214
          Typha domingensis. Southern Cat-Tail.
3217
          Typha latifolia. Common Cat-Tail.
3220
          Urtica spp. Stinging Nettle (Stinging Nettl).
3223
          Uniola spp. Uniola.
3226
          Uniola latifolia. Broad-Leaved Spike Grass (Bd-Lv Spk Grs).
3229
          Uniola laxa. Slender Spike Grass (Sl Spike Grass).
3230
          Urtica dicila. Stinging Nettle (Stng Nettle).
3232
          Utricularia spp. Bladderwort.
3235
          Uvularia spp. Bellwort.
3238
          Valerianella spp. Lamb's-Lettuce.
3241
          Vallisneria americana. Tape Grass.
3244
          Veratrum viride. American White Hellebore (Am Wt Helebore).
3247
          Verbascum spp. Mullein.
3250
          Verbena spp. Vervain.
3253
          Verbesina spp. Crown-Beard.
3256
          Vernonia spp. Ironweed.
3259
          Veronica spp. Speedwell.
3262
          Vicia spp. Vetch.
3265
          Vinca minor. Periwinkle.
3268
          Viola spp. Violet.
3269
          Wolffia spp. Water-Meal.
3271
          Woodwardia areolata. Netted Chain Fern (Nettd Chan Frn).
3274
          Woodwardia virginica. Virginia Chain Fern.
3277
          Xanthium spp. Cocklebur.
3280
          Xyris spp. Yellow-Eyed Grass.
3283
          Yucca filamentosa. Silkgrass.
3286
          Zannichellia palustris. Horned Pondweed.
3289
          Zizania aquatica. Wild Rice.
3292
          Zizaniopsis miliacea. Water Millet.
3295
          Zizia aptera. Zizia.
3298
          Zostera marina. Eelgrass.
3301
          Lichens.
3304
          Unknown Fern.
3307
          Unknown Herb.
3310
          Unknown Grass.
3313
          Unknown Sedge.
3316
          Unknown Moss.
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### **BIRDS**

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| NUMBER | SPECIES              | Resid.<br>Freq. | NUMBER       | SPECIES  | Resid.<br>Freq. |
|        |                      |                 |              | <del>*************************************</del> | -               |
| 6007   | Common Loon          | 3,2             | 6332         | Sharp-Shinned Hawk                               | 3,2             |
| 6011   | Red-throated Loon    | 3,2             | 6333         | Cooper's Hawk                                    | 3,3             |
| 6002   | Red-necked Grebe     | 3,3             | 6337         | Red-Tailed Hawk                                  | 4,2             |
| 6003   | Horned Grebe         | 3,2             | 6339         | Red-Shouldered Hawk                              | 4,2             |
| 6006   | Pied-billed Grebe    | 4,2             | 6343         | Brood-Winged Hawk                                | 1,2             |
| 6117   | Gannet               | 3,3             | 6347         | Rough-Legged Hawk                                | 3,2             |
| 6120   | Double-Cr. Cormorant | 2,2             | 6349         | Golden Eagle                                     | 3,3             |
| 6194   | Great Blue Heron     | 4,2             | 6352         | Bald Eagle                                       | 4,4             |
| 6201   | Green Heron          | 1,1             | 6331         | Marsh Hawk                                       | 3,2             |
| 6200   | Little Blue Heron    | 1,2             | 6364         | Osprey   | 1,1             |
| 6198   | Cattle Egret         | 1,2             | 6356         | Peregrine Falcon                                 | 3,4             |
| 6196   | Common Egret         | 1,2             | 6357         | Merlin   | 3,3             |
| 6197   | Snowy Egret          | 1,2             | 6360.        | American Kestrel                                 | 4,2             |
| 6199   | Louisiana Heron      | 1,2             | 6289         | Bobwhite   | 4,1             |
| 6202   | BlkCr. Night Heron   | 4,2             | 6309         | Rg-Necked Pheasant                               | 4,2             |
| 6203   | YelCr. Night Heron   | 1,3             | 6208         | King Rail  | 4,2             |
| 6191   | Least Bittern        | 1,2             | <b>621</b> 1 | Clapper Rail                                     | 4,2             |
| 6190   | American Bittern     | 1,2             | 6212         | Virginia Rail                                    | 4,2             |
| 6186   | Glossy Ibis          | 1,2             | 6214         | Sora   | 1,3             |
| 6178   |                      | 4,3             | 6216         | Black Rail                                       | 1,3             |
| 6180   |                      | 3,2             | 6218         | Purple Gallinule                                 | 1,3             |
| 6172   | Canada Goose         | 3,2             | 6219         | Common Gallingle                                 | 1,2             |
| 6171   | WtFronted Goose      | 2,3             | 6221         | American Coot                                    | 3,2             |
| 6169   | Snow Goose           | 3,2             | 6274         | Semipalmated Plover                              | 1,2             |
| 6132   | Mallard              | 4,2             | 6277         | Piping Plover                                    | 1,2             |
| 6133   | Black Duck           | 4,2             | 6273         | Killdeer   | 4,2             |
| 6135   | Gadwall              | 2,2             | 6270         | B1k-Bellied Plover                               | 3,2             |
| 6143   | Pintail              | 3,2             | 6283         | Ruddy Turnstone                                  | 2,3             |
| 6139   | Green-Winged Teal    | 3,2             | 6228         | Am. Woodcock                                     | 4,2             |
| 6140   | Blue-Winged Teal     | 4,2             | 6230         | Common Snipe                                     | 3,2             |
| 6136   | European Wigeon      | 3,3             | 6265         | Whimbrel   | 2,2             |
| 6137   | American Wigeon      | 3,2             | 6261         | Upland Plover                                    | 2,3             |
| 6142   | Shoveler             | 3,3             | 6263         | Spotted Sandpiper                                | 1,2             |
| 6144   | Wood Duck            | 1,2             | 6256         | Solitary Sandpiper                               |                 |
| 6146   | Redhead              | 3,2             | 6258         | Willet   | 1,2             |
| 6150   | Ring-Necked Duck     | 3,2             | 6254         | Greater Yellowlegs                               | 2,2             |
| 6147   | Canvasback           | 3,2             | 6255         | Lesser Yellowlegs                                | 2,2             |
| 6148   | Greater Scaup        | 3,2             | 6234         | Knot   | 2,3             |
| 6149   | Lesser Scaup         | 3,2             | 6239         | Pectoral Sandpiper                               | 2,2             |
| 6151   | Common Goldeneye     | 3,2             | 6240         | White-Rumped Sandpiper                           | 2,2             |
| 6153   | Bufflehead           | 3,2             | 6241         | Baird's Sandpiper                                | 2,3             |
| 6154   | 01dsquaw             | 3,2             | 6242         | Least Sandpiper                                  | 3,2             |
| 6165   | White-winged Scoter  | 3,2             | 6243         | Dunlin   | 3,2             |
| 6166   | Surf Scoter          | 3,2             | 6231         | Short-B. Dowitcher                               | 2,2             |
| 6163   | Black Scoter         | 3,2             | 6233         | Stilt Sandpiper                                  | 2,2             |
| 6167   | Ruddy Duck           | 3,2             | 6246         | Semipalm. Sandpiper                              | 2,2             |
| 6131   | Hooded Merganser     | 4,3             | 6247         | Western Sandpiper                                | 2,2             |
| 6129   | Common Merganser     | 3,2             | 6262         | Buff-Br. Sandpiper                               | 2;3             |
| 6130   | Red-Br. Merganser    | 3,2             | 6249         | Marbled Godwit                                   | 2,3             |
| 6325   | Turkey Vulture       | 4,1             | 6248         | Sanderling                                       | 4,2             |
| 6326   | Black Vulture        | 4,1             | 6225         | American Avocet                                  | 2,3             |
|        |                      |                 |              |  |                 |

|              |                                      | sid.        |                |  | id.<br>1.       |
|--------------|--------------------------------------|-------------|----------------|--|-----------------|
|              |                                      | Res:<br>Fre |                |  | Resid.<br>Freq. |
| NUMBER       | SPECIES                              | <u> </u>    | NUMBER         | SPECIES                                  | <u> </u>        |
| 6222         | Namehous Bholomes                    | 2 2         | 6617           | Davida Uda a Carallara                   | 1 2             |
| 6223<br>6042 | Northern Phalarope<br>Glaucous Gull  | 2,2<br>3,2  | 6613           |  | 1,2             |
| 6042         | Iceland Gull                         | 3,2         | 6612           |  | 1,1             |
| 6043         | Gt. Blk-Backed Gull                  | 4,1         | 6611           |  | 1,2<br>1,1      |
| 6051         | Herring Gull                         | 4,1         | 6477           | Purple Martin<br>Blue Jay                | 4,2             |
| 6054         | Ring-Billed Gull                     | 4,1         | 6488           | Common Crow                              | 4,2             |
| 6058         | Laughing Gull                        | 1,2         | 6490           | Fish Crow                                | 4,2             |
| 6060         | Bonaparte's Gull                     | 2,2         | 6736           | Carolina Chickadee                       | 4,1             |
| 6063         | Gull-Billed Tern                     | 1,2         | 6731           | Tufted Titmouse                          | 4,1             |
| 6069         | Forster's Tern                       | 1,2         | 6727           | White Br. Nuthatch                       |                 |
| 6070         | Common Tern                          | 1,1         | 6728           | Red Br. Nuthatch                         | 3,2             |
| 6074         | Least Tern                           | 1,2         | 6729           | Brown-Head. Nuthatch                     |                 |
|              | Royal Tern                           | 1,2         | 6726           | Brown Creeper                            | 4,2             |
|              |                                      | 2,2         | 6721           | House Wren                               |                 |
|              | Black Tern                           | 2,2         | 6722           | Winter Wren                              | 3,2             |
| 6080         | Black Skimmer                        | 1,2         | 6718           |  | 4,1             |
| 6316         |                                      |             | 6725           | Carolina Wren<br>Lg. Bill. Marsh Wren    | 4,2             |
| 6387         | Yellow-Billed Cuckoo                 | 1,1         | 6724           | ShtBill. Marsh Wren                      | 1,2             |
| 6388         | Black-Billed Cuckoo                  | 1,2         | 6703           | Mockingbird                              | 4,1             |
|              | Barn Ow1                             | 4,2         | 6704           | Catbird                                  | 4,2             |
|              | Screech Owl                          | 4,1         | 6705           | Brown Thrasher                           | 4,2             |
|              | Great Horned Owl                     |             | 6761           | American Robin                           | 4,1             |
|              |                                      | 4,1         | 6755           | Wood Thrush                              | 1,1             |
|              |                                      | 4,3         | 6759           | Hermit Thrush                            | 3,1             |
| 6367         | Short-Eared Owl                      | 3,2         | 6758           | Swainson's Thrush                        | 2,2             |
| 6372         | Saw-Whet Ow1                         | 4,3         | 6757           | Gray-Cheeked Thrush                      | 2,2             |
| 6416         | Chuck-Will's Widow                   | 1,1         | 6756           | Veery                                    | 1,1             |
| 6417         | Whip-Poor-Will                       | 1,1         | 6766           | Eastern Bluebird                         | 4,2             |
| 6420         | Common Nighthawk                     | 1,2         | 6751           | Blue-Gr. Gnatcatcher                     | 1,1             |
| 6423         | OHILIMIC) OHILL                      | 1,1         | 6748           |  | 4,2             |
| 6428         | Ruby-T. Hummingbird                  | 1,2         | 6749           | Ruby-Cr. Kinglet                         | -,              |
| 6390         | Belted Kingfisher                    |             | 6697           | Water Pipit                              | 3,2             |
|              | Yellow-Sh. Flicher                   |             | 6619           | Cedar Waxwing                            | 4,2             |
| 6405         | Pileated Woodpecker                  |             | 6622           | Loggerhead Shrike                        | 4,3             |
| 6409         | Red-Bellied Woodpecker               | 4,1         | 6493           | Starling                                 | 4,1             |
| 6406         | Red-Headed Woodpecker                | 4,2         | 6631           | White-Eyed Vireo<br>Yellow-Throat. Vireo | 1,2             |
| 6402         | Yellow-B. Sapsucker                  | 4,2         | 6628           | Solitary Vireo                           | 1,2             |
| 6393         | Hairy Woodpecker                     | 4,2         | 6629           | •  | 1,2             |
| 6394         | Downy Woodpecker                     | 4,1         | 6624           | Red-Eyed Vireo                           | 1,1             |
| 6444         | Eastern Kingbird                     | 1,2<br>1,1  | 6626           | Philadelphia Vireo                       | 2,3             |
| 6452         | Gt. Crest. Flycatcher Eastern Phoebe | 1,1         | 6627 -<br>6636 | Warbling Vireo<br>Blk&-White Warbler     | 1,2             |
| 6456<br>6463 | Yellow-Bellied Flyc.                 | 2,2         | 6637           | Prothonotary Warbler                     | 1,2<br>1,1      |
| 6465         | Acadian Flycatcher                   | 1,1         | 6639           | Worm-Eating Warbler                      | 1,2             |
| 6466         | Traill's Flycatcher                  | 1,3         | 6642           | Golden-Wing. Warbler                     | 1,2             |
| 6467         | Least Flycatcher                     | 1,2         | 6641           | Blue-Winged Warbler                      | 1,2             |
| 6461         | Eastern Wood Peewee                  | 1,2         | 6647           | Tennessee Warbler                        | 1,2             |
| 6459         | Olive-Sided Flyc.                    | 2,2         | 6645           | Nashville Warbler                        | 2,2             |
| 6474         | Horned Lark                          | 4,2         | 6648           | Parula Warbler                           | 1,3             |
| 6614         | Tree Swallow                         | 1,2         | 6652           | Yellow Warbler                           | 1,2             |
| 6616         | Bank Swallow                         | 1,2         | 6657           | Magnolia Warbler                         | 1,1             |
|              |                                      | -           | 6650           | Cape May Warbler                         | 2,2             |
|              |                                      |             |                | · ·                                      | -               |

|    | NUMBER       | SPECIES                              | Resid.<br>Freq. |
|----|--------------|--------------------------------------|-----------------|
|    | 6654         | Blk. Thr. Blue Warb.                 | 1,1             |
|    | 6655         | Myrtle Warbler                       | 3,1             |
|    | 6667         | Blk. Thr. Green War.                 | 1,1             |
|    | 6658         | Cerulean Warbler                     | 1,2             |
|    | 6662         | Blackburnian Warbler                 | 1,2             |
|    | 6663         | YelThroated Warbler                  | 1,1             |
|    | 6659         | Chestnut-Sided Warbler               | 1,1             |
|    | 6660         | Bay-Breast, Warbler                  | 2,2             |
|    | 6661         | Blackpoll Warbler                    | 2,2             |
|    | 6671         | Pine Warbler                         | 4,2             |
|    | 6673         | Prairie Warbler                      | 1,1             |
|    | 6672         | Palm Warbler                         | 3,3             |
|    | 6674         | Oven Bird                            | 1,1             |
| •  | 6675         | North. Waterthrush                   | 1,2             |
|    | 6676         | La. Waterthrush                      | 1,2             |
|    | 6677         | Kentucky Warbler                     | 1,1             |
|    | 6678<br>6679 | Connecticut Warbler Mourning Warbler | 2,2             |
| ٠. | 6681         | Yellowthroat                         | 2,2             |
|    | 6683         | Yellow-Breast. Chat                  | 4,1             |
| •  | 6684         | Hooded Warbler                       | 1,1<br>1,1      |
|    | :6685        | Wilson's Warbler                     | 2,3             |
|    | 6686         | Canada Warbler                       | 1,1             |
|    | 6687         | American Redstart                    | 1,1             |
|    | 6688         | House Sparrow                        | 4,1             |
|    | 6494         | Bobolink                             | 1,2             |
|    | 6501         | Eastern Meadowlark                   | 4,1             |
|    | 6498         | Red-Wing. Blackbird                  | 4,1             |
|    | 6506         | Orchard Oriole                       | 1,1             |
|    | 6507         | Baltimore Oriole                     | 1,2             |
|    | 6509         | Rusty Blackbird                      | 3,2             |
|    | 6513         | Boat-Tailed Grackle                  | 4,2             |
|    | 6511         | Common Grackle                       | 4,1             |
|    | 6495         | Brown-Head. Cowbird                  | 4,2             |
|    | 6608         | Scarlet Tanager                      | 1,1             |
|    | 6610         | Summer Tanager                       | 1,2             |
|    | 6593         | Cardinal                             | 4,1             |
|    | 6595         | Rose-Br. Grosbeak                    | 1,2             |
|    | 6597<br>6598 | Blue Grosbeak<br>Indigo Bunting      | 1,2             |
|    | 6604         | Dickcissel                           | 1,1             |
|    | 6514         | Evening Grosbeak                     | 1,3<br>3,2      |
|    | 6517         | Purple Finch                         | 4,2             |
|    | 6519         | House Finch                          | 4,2             |
|    | 6533         | Pine Siskin                          | 3,3             |
|    | 6529         | American Goldfinch                   | 4,2             |
|    | 6521         | Red Crossbill                        | 3,3             |
|    | 6587         | Rufous-Sided Towhee                  | 4,2             |
|    |              | Savannah Sparrow                     | 4,2             |
|    | 6546         | Grasshopper Sparrow                  | 1,1             |
|    | 6547         | Henslow's Sparrow                    | 1,2             |
|    |              |                                      |                 |

| NUMBER       | SPECIES              | Resid. |
|--------------|----------------------|--------|
| 6549         | Sharp-Tail. Sparrow  | 4,2    |
| 6550         | Seaside Sparrow      | 4,2    |
| 6540         | Vesper Sparrow       | 4,2    |
| 6575         | Bachman's Sparrow    | 1,3    |
| 6567         | Slate-Colored Junco  | 4,2    |
| 6559         | Tree Sparrow         | 3,1    |
| 6560         | Chipping Sparrow     | 4,2    |
| 6563         | Field Sparrow        | 4,1    |
| 6554         | White-Crown. Sparrow | 3,2    |
| 655 <b>8</b> | White-Thr. Sparrow   | 3,1    |
| 6585         | Fox Sparrow          | 3,2    |
| 6583         | Lincoln's Sparrow    | 2,2    |
| 6584         | Swamp Sparrow        | 4,1    |
| 6581         | Song Sparrow         | 4,1    |
| 6536         | Lapland Longspur     | 3,3    |
| 6534         | Snow Bunting         | 3,2    |
| 6310         | Wild Turkey          | 4,3    |
|              |                      |        |

#### Source:

. 1974. <u>List of Species</u>
Numbers and Recommended Band Sizes.
American Ornithological Union.

Robbins, Chandler S. and Willet T. Van Velzen. 1968. <u>Field List of the Birds of Maryland</u>. Maryland Ornithological Society. Baltimore.

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V.

# MAMMALS ....

|   | Resi.                           | Freq |
|---|---------------------------------|------|
| 5034 Bat, Big Brown. Eptes                              | sicus fuscus. 4,                | ī    |
|   | elle. Pipistrellus subflavus,   |      |
| 5036 Bat, Evening. Nyctice                              |                                 |      |
| 5037 Bat, Hoary. Lasiurus                               |                                 | 3    |
| 5038 Bat, Keen's Myotis. M                              | Myotis keenii. 4,               | 1    |
| 5039 Bat, Little Brown. My                              | yotis lucifugus. 4,             | 1    |
| 5040 Bat, Red. Lasiurus bo                              | orealis. 4,                     | ł    |
| 5041 Bat, Silver Haired. I                              | Lasionycteris noctivagans. 2,-  | -    |
| 5002 Beaver. Castor canade                              |                                 |      |
| 5026 Chipmunk, Eastern. Ta                              |                                 |      |
| 5025 Cottontail, Eastern.                               | Sylvilagus floridanus. 4,3      |      |
| 5015 Deer, White-Tailed. O                              | Odocoileus virginianus. 4,3     |      |
| 5028 Fox, Gray. Urocyon ci                              |                                 |      |
| 5030 Fox, Red. Vulpes vulp                              |                                 |      |
| 5042 Lemming, Southern Bog                              | g. Synaptomus cooperi. 4,-      |      |
| 5014 Mink. Mustela vison.                               | 4,-                             | -    |
| 5021 Mole, Eastern. Scalor                              | •                               |      |
| 5004 Mole, Star-Nosed. Cor                              |                                 |      |
| Mouse, Deer. Peromyso                                   |                                 |      |
|   | st. Reithrodontomys humulis. 4, |      |
| 5012 Mouse, House. Mus mus                              |                                 |      |
| 5031 Mouse, Meadow Jumping                              |                                 |      |
| 5018 Mouse, White-Footed.                               |                                 |      |
| 5016 Muskrat. Ondatra zibe                              | •                               |      |
| 5006 Opossum. Didelphis ma                              |                                 |      |
| 5008 Otter, River. Lutra                                |                                 |      |
| 5020 Raccoon. Procyon loto                              | -                               |      |
| 5017 Rat, Marsh Rice. Orzo                              |                                 |      |
| 5045 Rat Norway. Rattus no                              |                                 |      |
| 5005 Shrew, Least. Cryptot<br>5024 Shrew, Masked. Sorex | •                               |      |
| 5046 Shrew, Pigmy. Microso                              | •                               |      |
| 5001 Shrew, Short-Tailed.                               |                                 |      |
| 5047 Shrew, Southeastern.                               |                                 |      |
| 5010 Skunk, Striped. Mephi                              |                                 |      |
|   | k. Sciurus niger vulpinus. 4,3  |      |
| 5022 Squirrel, Gray. Scium                              | <u> </u>                        |      |
| 5027 Squirrel, Red. Tamias                              |                                 | 2    |
|   | lying. Glaucomys volans. 4,1    |      |
| 5011 Vole, Meadow. Microtu                              | -,, -                           |      |
| 5048 Vole, Pine. Pitymys p                              | •                               |      |
| 5013 Weasel, Long-Tailed.                               |                                 |      |
| 5032 Woodchuck. Marmota mo                              |                                 |      |

#### Source:

Paradiso, John L. 1969. Mammals of Maryland. North American Fauna, Number 66. Bureau of Sport Fisheries and Wildlife. U.S. Government Printing Office, Washington, D.C.

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## HERPTILES

| CAUDATA                               |   | Resid.<br>Freq.        |
|---------------------------------------|---|------------------------|
| 7006                                  | Dusky salamander, Northern. Desmognathus fuscus fuscus.     |                        |
| 7009                                  |   | 4,-                    |
| · · · · · · · · · · · · · · · · · · · | Four-toed salamander. Hemidactylium scutatum.               | 4,-                    |
| 7001                                  | Hellbender. Cryptobranchus alleganiensis alleganiensis.     | 4,4                    |
| 7013                                  | Long-tailed salamander. Eurycea longicauda longicauda.      | 4,-                    |
| 7004                                  | Marbled salamander. Ambystoma opacum.                       | 4,-                    |
| 7010                                  | Mud salamander, Eastern. Pseudotriton montanus montanus.    | <u>4,-</u>             |
| 7007                                  | Red-backed salamander. Plethodon cinereus cinereus.         | 4,-                    |
| 7011                                  | Red salamander, Northern. Pseudotriton ruber ruber.         | 4,-                    |
| 7002                                  | Red-spotted newt. Notophthalmus viridescens viridescens.    | 4,-                    |
| 7008                                  | Slimy salamander. Plethodon glutinosus glutinosus.          | 4,-                    |
| 7003                                  | Spotted salamander. Ambystoma maculatum.                    | 4,-                    |
| 7005                                  | Tiger salamander, Eastern. Ambystoma tigrinum tigrinum.     | 4,4                    |
| 7012                                  | Two-lined salamander, Northern. Eurycea bislineata bisline  | ata. 4,-               |
|                                       |   |                        |
|                                       |   |                        |
|                                       |   |                        |
| SALIENTIA                             |   |                        |
|                                       | ·   |                        |
|                                       |   |                        |
| 7021                                  | American toad. Bufo americanus americanus.                  | 4,-                    |
| 7028                                  | Bullfrog. Rana catesbeiana.                                 | . 4,-                  |
| 7023                                  | Cricket frog, Northern. Acris crepitans crepitans.          | 4,-                    |
| 7022                                  | Fowler's toad. Bufo woodhousei fowleri.                     | 4,-                    |
| 7027                                  | Gray treefrog. Eastern. Hyla versicolor.                    | 4,-                    |
| 7034                                  | Gray treefrog., Southern. Hyla chrysoscelis.                | 4,-                    |
| 7029                                  | Green frog. Rana clamitans melanota.                        | 4,-                    |
| 7025                                  | Green treefrog. Hyla cinerea.                               | 4,-                    |
| 7031                                  | Leopard frog, Northern. Rana pipiens.                       | 4,-                    |
| 7035                                  | Leopard frog, Southern. Rana utricularia utricularia.       | 4,-                    |
| 7036                                  | Narrow-mouthed toad, Eastern. Gastrophryne carolinensis.    | 4,4                    |
| 7037                                  | New Jersey chorus frog. Pseudacris triseriata kalmi.        | 4,-                    |
| 7030                                  | Pickerel frog. Rana palustris.                              | 4,-                    |
| 7020                                  | Spadefoot, Eastern. Scaphiopus holbrooki holbrooki.         | 4,-                    |
| 7026                                  | Spring peeper, Northern. Hyla crucifer crucifer.            | 4,_                    |
| 7038                                  | Upland chorus frog. Pseudacris triseriata feriarum.         | 4,-                    |
| 7032                                  | Wood frog. Rana sylvatica sylvatica.                        | 4,-                    |
|                                       |   |                        |
|                                       |   |                        |
| SQUAMATA (                            | SAURIA)   |                        |
|                                       |   | •                      |
|                                       |   |                        |
| 7073                                  | Broad-headed skink. Eumeces laticeps.                       | 4,-                    |
| 7070                                  | Fence lizard, Northern. Sceloporus undulatus hyacinthinus.  | 4, <del>-</del><br>4,1 |
| 7072                                  | Five-lined skink. Eumeces fasciatus.                        |                        |
| 7074                                  | Six-lined racerunner. Cnemidophorus sexlineatus sexlineatus | 4,1                    |
| 7071                                  | Ground skink. Leiolopisma laterale.                         | ' 3                    |
| 7071                                  | orden derine neroroproma racerare.                          | 4,2                    |

|      |  | Resid    |
|------|--|----------|
| 7044 | Black racer, Northern. Coluber constrictor constrictor.        | <u>~</u> |
| 7046 | Black rat snake. Elaphe obsoleta obsoleta.                     | 4        |
| 7054 | Brown snake, Northern. Storeria dekayi dekayi.                 | 4        |
| 7059 | Copperhead, Northern. Agkistrodon contortrix mokasen.          | 4        |
| 7045 | Corn snake. Elaphe guttata guttata.                            | 4        |
| 7056 | Earth snake, Eastern. Virginia valeriae valeriae.              | 4        |
| 7058 | Garter snake, Eastern. Thamnophis sirtalis sirtalis.           | 4        |
| 7042 | Hognose snake, Eastern. Heterodon platyrhinos.                 | 4        |
| 7047 | Kingsnake, Eastern. Lampropeltis getulus getulus.              | 4        |
| 7049 | Milk snake, Coastal plain. Lampropeltis triangulum temporalis. | 4        |
| 7048 | Milk snake, Eastern. Lampropeltis triangulum triangulum.       | 4        |
| 7060 | Mole snake. Lampropeltis calligaster rhombomaculata.           | 4        |
| 7052 | Queen snake. Natrix septemvittata.                             | 4        |
| 7061 | Rainbow snake. Farancia erytrogramma erytrogramma.             | 4        |
| 7055 | Red-bellied snake, Northern. Storeria o. occipitomaculata.     | 4        |
| 7057 | Ribbon snake, Eastern. Thamnophis sauritus sauritus.           | 4        |
| 7041 | Ringneck snake, Northern. Diadophis punctatus edwardsi.        | 4,       |
| 7043 | Rough green snake. Opheodrys aestivus.                         | 4        |
| 7050 | Scarlet snake, Northern. Cemophora coccinea copei.             | 4        |
| 7062 | Timber rattlesnake. Crotalus horridus horridus.                | 4        |
| 7053 | Water snake, Northern. Natrix sipedon sipedon.                 | 14       |
| 7040 | Worm snake, Eastern. Carphophis amoenus amoenus.               | 4        |

#### CHELONIA

| 7091 | Atlantic green turtle. Chelonia mydas mydas.                  | 2,4 |
|------|---|-----|
| 7092 | Atlantic leatherback. Dermochelys coriacea coriacea.          | 2,4 |
| 7093 | Atlantic loggerhead. Caretta caretta caretta.                 | 2,4 |
| 7094 | Atlantic ridley. Lepidochelys kempi.                          | 2,4 |
| 7084 | Bog turtle. Clemmys muhlenbergi.                              | 4,4 |
| 7085 | Box turtle, Eastern. Terrapene carolina carolina.             | 4,1 |
| 7095 | Cumberland turtle. Feral. Chrysemys scripta troosti.          | 4,- |
| 7086 | Diamondback terrapin, Northern. Malaclemys terrapin terrapin. | 4,1 |
| 7087 | Map turtle. Graptemys geographica.                            | 4,- |
| 7081 | Mud turtle, Eastern. Kinosternon subrubrum subrubrum.         | 4,1 |
| 7088 | Painted turtle, Eastern. Chrysemys picta picta.               | 4,1 |
| 7089 | Red-bellied turtle. Chrysemys rubriventris.                   | 4,1 |
| 7096 | Red-eared turtle. Feral. Chrysemys scripta elegans.           | 4   |
| 7082 | Snapping turtle, Common. Chelydra serpentina serpentina.      | 4,1 |
| 7083 | Spotted turtle. Clemmys guttata.                              | 4,1 |
| 7080 | Stinkpot. Sternotherus odoratus.                              | 4,1 |
| 7097 | Wood turtle. Clemmys insculpta.                               | 4,1 |
|      |   | . , |

#### Sources:

. 1973. "Endangered Amphibians and Reptiles of Maryland: A Special Report." Bulletin of the Maryland Herpetological Society. The Natural History Society of Maryland, Inc. Vol. 9, No. 3.

Harris, Herbert S. 1975. "Distributional Survey (Amphibia/Reptilia): Maryland and D.C." <u>Bulletin of the Maryland Herpetological Society</u>. The Natural History Society of Maryland, Inc. Vol. 11, No. 3.

McCauley, Robert H. Jr. Ph.D. 1945. The Reptiles of Maryland and the District of Columbia. Hagerstown, Maryland.

### D & D+ SOILS

#### Anne Arundel County

Bm - Bibb (D)
Ck, Cm - Colemantown (D)
Ek, En - Elkton (D)
Fa - Fallsington (D)
Mt - Mixed Alluvial (D+)
Os - Osier (D)
Ot - Othello (D)

Sr, Ss - Shrewsbury (D)

#### Baltimore County

Ad - Aldino (D)
Av - Alluvial (D)
Ba - Baile (D)
Co, Cn - Chrome (D)
Du - Dunning (D)
Em, En, Eo - Elkton (D)
Fa, Fs - Fallsington (D)
Hb - Hatboro (D)
Ke, Ks, Ku - Kelly (D)
Ll, Lm, Ln, Lo - Lenoir (D)
Lr - Lenardtown (D)
Mh, Mo - Meluin (D)
Ot - Othello (D)
Po - Pocomoke (D)
Wa, Wc - Wachung (D)

#### Calvert County

Ek - Elkton (D)
Fs - Fallsington (D)
Mu - Mixed Alluvial (D<sup>+</sup>)
Ot - Othello (D)

#### Cecil County

Ad - Aldino (D)
Ba - Baile (D)
Cm, Cn - Chrome (D)
El, Em - Elkton (D)
Fa, Fm - Fallsington (D)
Ha - Hatboro (D)
Lo - Leonardtown (D)
Mu - Mixed Alluvial (D<sup>+</sup>)
Oh - Othello (D)
Wa - Wachung (D)

#### Charles County

Bo - Bibb (D)
Ek - Elkton (D)
Fs - Fallsington (D)
Le - Leonardtown (D)
Os, Ot - Othello (D)
Ov - Osier (D)

#### Harford County

Ad - Aldino (D)
Av - Alluvial (D)
Ba - Baile (D)
Cr - Chrome (D)
En - Elkton (D)
Fs - Fallsington (D)
Hb - Hatboro (D)
Ke, Kf - Kelly (D)
Kr - Kinkara (D)
Lr - Leonardtown (D)
Ut - Othello (D)
Wa, Wc - Wachung (D)

#### Prince Georges County

Bn, Bo, Br - Bibb (D)
Cl - Colemantown (D)
Ek, El - Elkton (D)
Fl, Fs, Fu - Fallsington (D)
Ha - Hatboro (D)
Hy - Hyde (D)
Jo, Ju - Johnston (D)
Le - Leonardtown (D)
Mw - Mixed Alluvial (D+)
Ol, Ot - Othello (D)
Pr - Plummer (D)
Sm, Sn - Shrewsbury (D)

## WELL-DRAINED SOILS

#### Anne Arundel County

Ca, Cb - Chillum
Cc, Cd - Christiana
Cn, Co, Cp - Collington
Cr - Comus
Cs, Ct - Croom
Eo, Es, Eu, Er - Evesboro
Ga - Galestown
Hf, Hg, Hs, Ht, Hy, Hz - Howell
Mf - Marr
Mk, Mm, Matapeake
Mu, Mv, Mw, Mx - Monmouth
My, Mz - Muirkirk
Ru, Ry - Rumford
Sa, Sf, Sn - Sassafras
Wa - Westphalia

#### Baltimore County

Bm, Bn - Baltimore Bw, By - Brandywine Cc, Cg - Chester Ch, Ck, Cl - Chillum Cm - Christiana Cn, Co - Chrome Series Cv - Comus Cw - Conestoga Ed, Eg - Edgemont Eh, Ek, El - Elioak Es - Elsinboro Ft - Fort Mott Ga - Galestown Gc, Gg, Gl - Glenelg Ha - Hagerstown Ho, Hr, Hs - Hollinger Jp, Ju - Joppa Le, Lf, Lg, Lh - Legore Mb, Mc, Md, Me, Mg, Mh - Manor Mk - Matapeake Ms - Montalto Mt - Mt. Airy Ne - Neshaminy Re, Rs, Ry - Relay Sh, Sl, Sn, Ss - Sassafras Su - Sunnyside

#### Calvert County

Ev - Evesboro
Ho, Hw, Hy - Howell
Ml - Marr
Mm, Mn - Matapeake
Oc - Ochlockonee
Rd, Re - Rumford
Sa, Sh, Sl, Sp, Sr - Sassafras
Wa - Westphalia

#### Cecil County

Au - Aura Ce - Chester Ch - Chillum C1B2 - Christiana Cm, Cn - Chrome Cs, Ct - Collington Cu - Comus Eo - Elsinboro Ev - Evesboro Ge - Glenelg Le, Lg - Legore Ml, Mm - Manor Mn, Mo - Matapeake Mt, Mv, My - Montalto Ne - Neshaminy Ru - Rumford Sa, Sg, Sf, Sr - Sassafras

#### Charles County

Au - Aura
ChB, ChC - Chillum
CrB, CrC - Croom
Ev - Evesboro
Ga - Galestown
GvE - Gravelly Land
Mg - Magnolia
Ml - Marr
Mm, Mn - Matapeake
Oc - Ocklockonee
Rd, Rg - Rumford
SaE - Sandy Land
Sh - Sassafras
Wa, We - Westphalia
Wk, Wm - Wickham

#### Harford County

Br - Brandywine Cc, Cg - Chester Ch, Ck - Chillum CrE - Chrome Cv - Comus Eh - Elioak Es - Elsinboro EvC - Evesboro Gc, Gg - Glenelg Jp - Joppa Le, Lg, Lf - Legore Mb, Mc, Md, Mg - Manor Mk - Matapeake Ms - Montalto Ne, Ns - Neshaminy Sh, Sl, Ss - Sassafras Wh - Whiteford

#### Prince Georges County

Au, Av - Aura Ca, Cb - Chillum Cc, Cd, Ce, Cf - Christiana Cm, Co - Collington Cr - Comus Cs, Ct, Cu - Croom Em, En, Eu - Elsinboro Ge, Re, We - Evesboro Ga, Gd, Gm, Ge - Galestown Gn, Go - Glenelg Hc - Howell Mf, Mg - Magnolia Mh, Mk - Manor Ml - Marr Mn, Mm, Mp - Matapeake Mx - Monmouth Mz - Muirkirk Oc, Oh, Ok - Ochlockonee Rd, Re - Rumford SaE - Sandy Land Sf, Sg, Sl, Sh, Sk - Sassafras St, Su, Sw - Sunnyside Wa, Wb, We - Westphalia

•

## WATERSHED DESIGNATIONS

STATE OF MARYLAND

#### WATER RESOURCES ADMINISTRATION

#### Watershed Designations

```
- Major Basin
              Minor Basin
               -Sub-Basin
                 - Segment
            Chesapeake Bay (Proper)
02-13-99
                 Lower Chesapeake Bay (below north side original Bay Bridge)
        -98
                 Upper Chesapeake Bay (above north side original Bay Bridge)
        -99
            Lower Susquehanna River Area - 3
02-12-02
                 Susquehanna River (below Conowingo Dam)
        -01
                 Dear Creek drainage
        -02
                 Octoraro Creek drainage
        -03
                 Susquehanna River (above Dam)
        -05
                 Broad Creek drainage
        -06
                 Castleton area drainage
        -07
                 Oakwood area drainage
        -08
                 Pennsylvania line area drainage
        -09
                 Havre De Grace area drainage
        -10
                 Bainbridge area drainage
        -11
                 Camp Ramblewood area drainage
        -12
                 Susquehanna River (Pennsylvania area) drainage
        -15
02-13-06
            Elk River Area - 9
        -01
                 Sassafras River drainage
        -02
                 Elk River, mainstem
        -03
                 Bohemia River drainage
                 Back Creek drainage
        -04
        -06
                 Northeast River drainage
                 Furnace Bay area drainage
        -07
                 Stillpond - Fairlee area drainage
        -08
                 Christina River drainage (Delaware)
        -09
                 Crystal Beach area drainage
        -10
                 Elk Neck (Elk River) area drainage
        -11
                 Port Herman area drainage
        -12
                 Elk River headwaters area drainage
        -13
                 Elk Neck (Bay) area drainage
        -14
```

| 02-13-0 | 7           | Bush  | River Area - 10  |              |
|---------|-------------|-------|--|--------------|
| 4.4     | O.T         |       | Contin Character Name to   |              |
|         | -01         |       | Swan Creek drainage  |              |
| •       | -02         |       | Bush River drainage  |              |
|         | -03<br>-04  |       | Bynum Run drainage   |              |
|         |             |       | Winters Run drainage   | •            |
|         | <b>-</b> 05 |       | Aberdeen Proving Ground area drainage  |              |
|         | -00         |       | Susquehanna Flats area drainage  |              |
| 02-13-0 | 8           | Gunp  | owder River Area - 11  |              |
|         | -01         |       | Gunpowder River drainage   |              |
|         | <b>-</b> 02 |       | Gunpowder Falls drainage   | ***          |
|         | <b>-0</b> 3 |       | Little Gunpowder Falls drainage  |              |
|         | -04         |       | Bird River drainage  | . ;          |
|         | -05         |       | Middle River drainage  | ,            |
|         | -06         |       | Browns Creek area drainage   | •            |
|         | -07         |       | Seneca Creek drainage  |              |
|         |             |       |  |              |
| 02-13-0 | 9           | Patar | osco River Area - 12   |              |
|         | -01         |       | Back River drainage  | • • •        |
|         | -02         |       | South Branch Patapsco River drainage   |              |
|         | -03         |       | North Branch Patapsco River drainage   |              |
|         | -04         |       | Patapsco River drainage (confluence North and South<br>to Hanover Street Bridge) | Branch       |
|         | -05         |       | Inner Baltimore Harbor (Patapsco River from Hanover                              | Street to    |
|         |             |       | straight line between Hawkins Point and Sc                                       | llers Point) |
|         | -06         |       | North drainage to Inner Baltimore Harbor   | ,            |
|         | -07         |       | Outer Baltimore Harbor drainage (straight line betw                              | een Rock     |
|         |             |       | Point and North Point from Sollers Point)  |              |
|         | -08         |       | South drainage to Inner Baltimore Harbor   |              |
|         | -09         | •     | Bodkin area drainage   | ·            |
|         | -10         |       | Shallow Creek drainage   |              |
| 02-13-1 | 0           | West  | Chesapeake Bay Area - 13   |              |
|         | -01         |       | Magothy River drainage   |              |
|         | -02         |       | Severn River drainage  |              |
|         | -03         |       | South River drainage   |              |
|         | -04         |       | West River drainage  | •            |
|         | -05         |       | Other drainage of West Chesapeake Bay area                                       | •            |
|         | -06         |       | Beverly Beach area drainage  |              |
|         | -07         |       | Bay Ridge area drainage  |              |
|         | -08         |       | Broadneck area drainage  |              |
|         | -09         |       | Pinehurst - Gibson area drainage   |              |

```
Patuxent River, mainstem
        -01
                 Western Run (Branch) drainage
        -02
        -03
                 Little Patuxent River drainage
        -04
                 Middle Patuxent River drainage
                 Other drainage of Patuxent River area (directly into
        -05
                          Chesapeake Bay)
        -06
                 Patuxent River east area drainage
        -07
                 Patuxent River southwest area drainage
        -08
                 Patuxent River west area drainage
        -09
                 Patuxent River headwaters area drainage
            Lower Potomac River Area - 16
02 - 14 - 01
        -02
                 Lower Potomac River, mainstem (from mouth to Marshall Hall)
        -03
                 Saint Mary's River drainage
        -04
                 Saint George Creek drainage
        -05
                 Breton Bay drainage
                 Saint Clement Bay drainage
        -06
        -07
                 Wicomico River drainage
        -08
                 Gilbert Swamp drainage
        -09
                 Zekiah Swamp drainage
        -10
                 Port Tobacco River drainage
        -11
                 Nanjemoy Creek drainage
        -12
                 Nattawoman Creek drainage
        ÷13
                 Potomac River mouth area drainage
        -14
                 Huggins Point Strait Point area drainage
        -15
                 White Neck Point to Colton Point area drainage
        -16
                 Morgantown area drainage
                 Cedar Point area drainage
        -17
        -18
                 Chicamuxen Creek to Riverside area drainage
        -19
                 Potomac Heights area drainage
        -20
                 Lower Potomac River area Virginia drainage
02-14-02
            Washington Metropolitan Area - 17
        -01
                 Potomac River, mainstem (from Marshall Hall to FR/MO County Line)
        -02
                 Piscataway Creek drainage
        -03
                 Anacostia River drainage
        -04
                 Rock Creek drainage
        -05
                 Bryan Point area drainage
        -06
                 Seneca Creek drainage
        -07
                 Washington, D.C. south area drainage
        -08
                 Central Washington, D.C. area drainage
        -09
                 Rockville-Bethesda area drainage
        -10
                 Poolesville area drainage
        -15
                 Washington-Metropolitan area Virginia drainage
```

02-13-11

Patuxent River Area - 14

## **CATEGORIES**

|      | GEOLOGIC  | (Landform)  | •           | ٠,      |
|------|-----------|---|-------------|---------|
|      | 1001      | Gorges  |             |         |
|      | 1002      | Distinctive mountain features                                 |             |         |
|      | 1003      | Cliffs, Bluffs  |             |         |
|      | 1004      | Natural rock outcrops of geologic significance                |             |         |
|      | 1005      | Manmade rock outcrops of geologic significance (and quarries) | road cuts   |         |
|      | 1006      | Natural sand, beach, dune features                            |             |         |
|      | 1007      | Fossil evidence   | • •         | •       |
|      | 1008      | Scarp   |             |         |
|      | 1009      | Other unusual geologic formations                             |             | •       |
|      |           | Section 1   |             |         |
|      |           |   |             |         |
| <br> | SOILS     |   |             |         |
|      | 2101      | Unusual soil groups; undisturbed by human activi              | tv          |         |
| . `  |           | CHARACT BOTT BLOCKS, MIGTS OUT DEA BY HAMMER GOOTIE           |             |         |
|      |           |   |             |         |
|      | HYDRQLOG] | rc .  |             |         |
|      |           | · ·   |             |         |
|      | 3091      | Significant and unusual water-land interfaces (i              | .e. islands |         |
|      | 3-72      | scenic stretches of coast, rivers, streams, lake              |             |         |
|      | 3092      | Whitewater stretches  | ,           |         |
|      | 3093      | Waterfalls  |             | ,       |
|      | 3094      | Natural Springs   |             | 1.1     |
|      | 3095      | Marshes, bogs, swamps, flats (coastline)                      |             | ,       |
|      | 3096      | Marshes, bogs, swamps, flats (inland)                         |             |         |
|      | 3097      | Aquifer recharge areas  |             |         |
|      | 3098      | Water areas supporting unusual or significant fr              | eshwater    |         |
|      |           | aquatic life  | •           |         |
|      | 3099      | Lakes, ponds of unusually low productivity                    |             |         |
|      | 3100      | Lakes, ponds of unusually high productivity                   | •           |         |
|      | 3101      | Unusual natural river, lake, pond                             |             |         |
| ٠.   | 3102      | Stream and marginal wetland habitat                           |             |         |
|      | 3103      | Floodplain  | •           |         |
|      | 3104      | Lake or pond  |             |         |
|      | 3105      | Other unusual hydrologic feature                              |             |         |
|      | 3_0/      |   |             |         |
|      |           | · · · · · · · · · · · · · · · · · · ·                         |             | ,       |
|      | BIOLOGICA | AL - FLORA  | 4           |         |
|      |           |   |             |         |
|      | 4001      | Rare, remnant or unique species of plants                     |             |         |
|      | 4002      | Unique plant community  |             |         |
|      | 4003      | Plant communities unique to a geographic area                 |             |         |
|      | 4004      | Individual plant specimen(s) of unusual signific              | ance (i.e.  | large · |
|      |           | trees)  | •           | J       |
|      | 4005      | Plant communities of unusual age or maturity                  |             |         |
|      | 4006      | Plant communities of unusual diversity and produ              | ctivity     |         |
|      | 4007      | Areas exhibiting outstanding seasonal color                   | <b>v</b>    |         |
|      | •         | <u> </u>  |             |         |

#### Category Code Sheet - cont.

| 4008 | Forest                    |
|------|---------------------------|
| 4009 | Managed Forest            |
| 4010 | Field or shrub vegetation |

#### BIOLOGICAL - FAUNA (terrestrial animals)

| 5091 | Habitat area of rare, endangered and unique species       |
|------|---|
| 5092 | Habitat area of unusual significance to a fauna community |
|      | (i.e. feeding, breeding, wintering, resting)              |
| 5093 | Fauna communities unusual to a geographic area            |
| 5094 | Habitat areas supporting fauna communities of unusual     |
|      | diversity and productivity                                |
| 5095 | Habitat areas exhibiting other interesting features       |

#### BIOLOGICAL FAUNA (birds)

| 6001 | Habitat areas of rare, endangered and unique species      |
|------|---|
| 6002 | Habitat area of unusual significance to a fauna community |
|      | (i.e. feeding, breeding, wintering, resting)              |
| 6003 | Fauna community unusual to a geographic area              |
| 6004 | Habitat areas supporting fauna communities of unusual     |
|      | diversity and productivity                                |

#### BIOLOGICAL FAUNA (aquatic life)

| 7091 | Habitat areas of rare, endangered and unique species       |
|------|--|
| 7092 | Habitat areas of unusual significance to a fauna community |
| 7093 | Fauna communities unusual to a geographic area             |
| 7094 | Habitat areas supporting fauna communities of unusual      |
|      | diversity and productivity                                 |

#### CULTURAL - AESTHETIC - VISUAL

| 8001 | Manmade features having unusual aesthetic features or        |
|------|--|
| •    | aesthetic significance due to natural setting (i.e. old mill |
| +    | along creek)   |
| 8002 | Scenic gravel or unimproved roads                            |
| 8003 | Vista points   |
| 8004 | Trail systems  |
| 8005 | Unusual juxtaposition of manmade and natural features        |
| 8006 | Unusually scenic area  |

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### WETLAND WILDLIFE RATING

A Wetland Wildlife Rating should be completed for all Natural Areas which include one or more of the wetland classes listed on the following page. These wetlands should be sampled according to the procedure outlined in the enclosed reprint by Frances C. Golet. The categories used in this procedure along with their significance coefficients and rank are summarized for your convenience.

Encode the data choice which describes the wetlands in the appropriate boxes and record percent of border for each use by "Surrounding Habitat." Determine the significance coefficient for each choice and multiply by the rank to get subscores. Record and total the subscores, and round up to the nearest whole number to get the Wetland Wildlife Rating. Record the resulting score in the appropriate boxes on "Card 3."

#### Wetland Classes

| i                           | Class     | Dominant |      |
|-----------------------------|-----------|----------|------|
| 5 acre minimum              | Richness  | Class    | Rank |
| 1. Open water               | 5 or more | 4,2      | 3.0  |
| 2. Deep marsh               | 4         | 3        | 2.5  |
| 3. Shallow marsh            | 3         | 7,6      | 2.0  |
| 4. Seasonally flooded flats | 2         | 1,8      | 1.5  |
| 5. Meadow                   | 1         | 5        | 1.0  |
| 6. Shrub swamp              |           |          |      |
| 7. Wooded swamp             |           |          |      |
| 8. Bog                      |           |          |      |

#### Size

|     |                                     | Rank |
|-----|-------------------------------------|------|
| 9.  | Very small - less than 10 acres     | 1.0  |
| 10. | Small - 10-50 acres                 | 1.5  |
| 11. | Medium-sized - 51-100 acres         | 2.0  |
| 12. | Large - 101-500 acres               | 2.5  |
| 13. | Very large - greater than 500 acres | 3.0  |

#### Site Types

|                           | Site Types | Rank |
|---------------------------|------------|------|
| 14. Upland-isolated       | 17, 18, 19 | 3.0  |
| 15. Upland-lakeside       |            | 2.5  |
| 16. Bottomland-isolated   | 15, 16     | 2.0  |
| 17. Bottomland-lakeside   |            | 1.5  |
| 18. Bottomland-streamside | 14         | 1.0  |
| 19. Bottomland-deltaic    |            |      |

#### Cover Types

- 20. Cover occupies more than 95 percent of the wetland area.
- 21. Cover occupies 76-95 percent of the wetland area, occurring in a peripheral band.
- 22. Cover occupies 76-95 percent of the wetland area, occurring in dense patches or diffuse open stands.
- 23. Cover occupies 26-75 percent of the wetland area, occurring in a peripheral band.
- 24. Cover occupies 26-75 percent of the wetland area, occurring in dense patches or diffuse open stands.
- 25. Cover occupies 5-25 percent of the wetland area, occurring in a peripheral band.
- 26. Cover occupies 5-25 percent of the wetland area, occurring in patches or diffuse open stands.
- 27. Cover occupies less than 5 percent of wetland area.

#### Cover Types (continued)

| Cover Types    | Rank |
|----------------|------|
| 24             | 3.0  |
| 23             | 2.5  |
| 22 <b>,</b> 26 | 2.0  |
| 20,21,25       | 1.5  |
| 27             | 1.0  |

#### Surrounding Habitat Types

|                                   | <u>Habitats</u>    | Rank |
|-----------------------------------|--------------------|------|
| 28. Agricultural or open land     | 2 or more of       |      |
| 29. Forest land                   | 28,29,30 making    | 3.0  |
| 30. Salt marshes                  | up more than 90%   |      |
| 31. Mining or waste disposal area | 1 or more of       |      |
| 32. Urban land                    | 28,29,30 making    | 2.0  |
| 33. Outdoor recreation facilities | up 50 <b>-</b> 90% |      |
|                                   | 1 or more of       |      |
|                                   | 28,29,30 making    | 1.0  |
|                                   | un less than 50%   |      |

#### Vegetative Interspersion

|            | Rank |
|------------|------|
| 34. Type 1 | 1.0  |
| 35. Type 2 | 2.0  |
| 36. Type 3 | 3.0  |

#### Juxtaposition

37. Hydrologically connected to other wetlands (different dom. class) or open water bodies within one mile.

(or)

Hydrologically connected to other wetlands (same dom. class) within 1/4 mile.

(or)

Wetland greater than 500 acres, with three or more wetland classes (including deep marsh or shallow marsh).

38. Hydrologically connected to other wetlands (different dom. class) or open water bodies from 1-3 miles away.

(or)

Hydrologically connected to other wetlands (same dom. class) from 1/4-1 mile away.

(or)

Within 1/2 mile of other wetlands (different dom. class) or open water bodies, but not hydrologically connected.

39. All other possibilities

|    | Rank |
|----|------|
| 37 | 3.0  |
| 38 | 2.0  |
| 39 | 1.0  |

CLASSIFICATION AND EVALUATION OF FRESHWATER WETLANDS AS WILDLIFE HABITAT IN THE GLACIATED NORTHEAST<sup>1,2</sup>

Francis C. Golet, Assistant Professor, Department of Forest and Wildlife Management, University Rhode Island.

#### Abstract

A detailed classification system for freshwater wetlands is presented along with ten criteria for the evaluation of wetlands as wildlife habitat. The results are based on a two-year field study of over 150 wetlands located throughout the state of Massachusetts. The major components of the classification system include wetland classes and subclasses, based on the dominant life form of vegetation and surface water depth and permanence; size categories; topographic and hydrologic location; surrounding habitat types; proportions and interspersion of cover and water; and vegetative interspersion. These components are combined with wetland juxtaposition and water chemistry to produce criteria for wetland evaluation. Using a system of specifications and ranks, wetlands can be arrayed according to their wildlife value for decision-making.

Wetlands traditionally have been regarded as waste areas. More than one-third of the nation's total original wetland acreage has been obliterated, and the remaining acres are fast disappearing (Shaw and Fredine, 1956). In the prairies and in the south, man has drained wetlands primarily for agricultural purposes. In the northeast, expansion of urban areas has created a growing need for land suitable for highway construction and commercial, industrial and housing development, often at the expense of wetlands.

During the last 10 years, several northeastern states, realizing the natural values of freshwater wetlands, enacted laws to control their alteration. Implementation of these laws has been generally unsuccessful because decision-makers lack appropriate criteria for wetland evaluation. In 1969 a research team of wildlife biologists, hydrogeologists, landscape planners and resource economists organized at the University of Massachusetts to develop a decision-making model for public management of freshwater wetlands (Larson, 1971).

This paper is a contribution of the Massachusetts Cooperative Wildlife Research Unit. The work was supported by the U.S. Department of the Interior, Office of Water Resources Research, as authorized under the Water Resources Research Act of 1964 (P.L. 88-379), Dr. Joseph S. Larson, Principal Investigator.

Reference: 1973. Trans. Northeast Fish & Wildlife Conf. 30:257-279.

This paper is a contribution of the wildlife sub-project toward evaluation of wetlands as wildlife habitat.

Early in this study, it became clear that a detailed wetland classification system was prerequisite to development of criteria for evaluation. The national classification system devised by Martin et al. (1953) has been used widely, but it is too generalized for wetlands research and management on a regional or statewide scale. Stewart and Kantrud (1971) produced a detailed system for the Prairie Pothole Region, but similar refinements are notably lacking in other parts of North America. Golet (1972) and Golet and Larson (1974) have described several of the more prominent systems being used throughout the United States and Canada.

Nearly all of these classification systems were developed to facilitate description and evaluation of waterfowl habitat. Because of the greatly expanded use of northeastern freshwater wetlands by educational groups, bird watchers, hikers, nature photographers, as well as sportsmen, the standard for evaluation in this study is maximum wildlife production and diversity. The classification system presented here identifies wetland features that determine the presence and abundance of a great variety of wildlife species. Criteria for wetland evaluation are developed from this system.

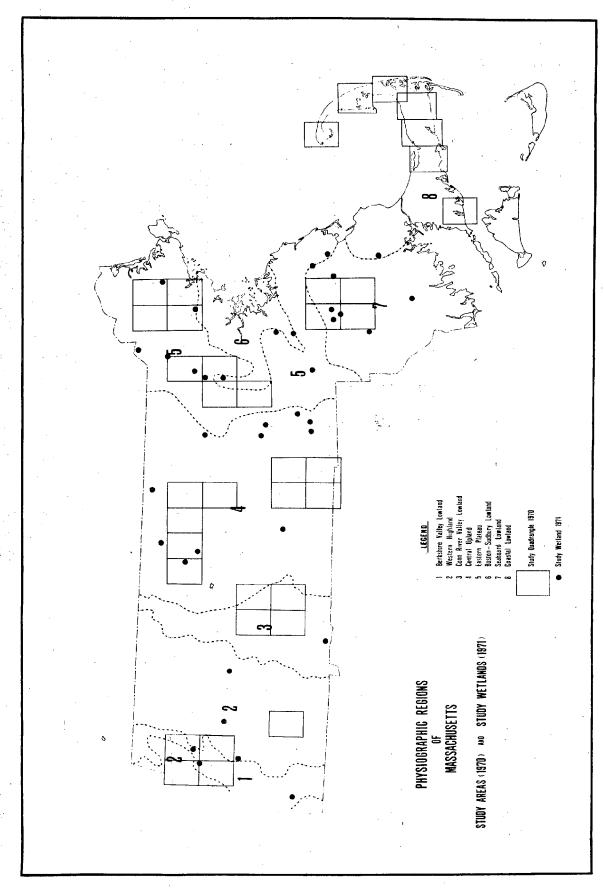
#### Acknowledgments

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#### Materials and Methods

During 1970 a reconnaissance study provided a broad range of qualitative data on the nature and diversity of 131 freshwater wetlands in Massachusetts. After refining earlier physiographic maps of the state (Office of River Basin Studies, 1954; Beaumont, 1956), I selected usually four or more U.S.G.S. map quadrangles as study areas within each physiographic region (Figure 1). These quadrangles were selected so as to include a maximum number of wetlands, a maximum diversity of surficial geologic substrates, both alkaline and acidic hydrochemical ground-water facies (Motts and Saines, 1969), and several wetlands deemed valuable as wildlife habitat by state or federal wildlife agencies.

Within each study area, I selected specific wetlands so as to achieve diversity with respect to the following criteria: hydrologic location, surficial



Physiographic regions of Massachusetts, study areas for wetland reconnaissance (1970) and high value study wetlands (1971). Figure 1.

geologic substrate, wetland class as outlined by Martin et al. (1953), size, and urban-rural context. Land-use maps (MacConnell and Garvin, 1956) were used in the selection and field study of wetlands. I obtained additional data from topographic maps, surficial geologic maps and 1:20,000 aerial photographs.

During 1971 I asked biologists from the Massachusetts Division of fisheries and Game and the Massachusetts Audubon Society to identify wetlands of high value to wildlife in the various physiographic regions. After adding several wetlands designated "high value" for waterfowl by the federal inventory (Office of River Basin Studies, 1954), I selected 38 high value wetlands and gathered detailed qualitative data on them in the field. The locations of these wetlands are designated by dots in Figure 1. Extensive literature review on the habitat requirements of wetland wildlife species supplemented field work (Golet, 1972). In addition, I reviewed and summarized nine years of unpublished water chemistry data collected by the Massachusetts Division of Fisheries and Game in 95 lakes and ponds located throughout the state.

#### Results

#### Classification of Freshwater Wetlands

Life forms and sub-forms of wetland vegetation. The classification of plant life forms was the first step toward wetland classification. Five life forms and 18 sub-forms are recognized (Figures 2 and 3). The forms represent obvious divisions of vegetation: trees, shrubs, emergents, surface plants and submergents. Because differences in wildlife value often exist between plants belonging to the same life form, I have divided each form into subforms which reflect not only differences in structure, but differences in ecology and stand density as well.

Below is a description of each life form and sub-form. Height classes given are average. Latin names are taken from the eighth edition of Gray's Manual (Fernald, 1950).

TREES (3 sub-forms). Woody plants greater than 20 ft tall.

- 1. Live deciduous trees. Living trees that lack leaves or needles during late fall, winter and early spring (e.g., Acer rubrum).
- 2. <u>Live evergreen trees</u>. Living trees that retain their leaves or needles throughout the year (e.g., <u>Picea mariana</u>).
- 3. Dead trees. Standing dead trees and tree stumps 5 ft or more in height.

SHRUBS (6 sub-forms). Woody plants less than 20 ft tall. Woody plants taller than 20 ft at maturity (and commonly called trees) are considered shrubs when less than 20 ft tall.

- 4. Tall slender shrubs. Shrubs 10 to 20 ft tall, having usually one distinct trunk, and unbranched for 3 ft or more above the ground (e.g., Alnus rugosa).
- 5. Bushy shrubs. Non-aquatic shrubs 4 to 7 ft tall, having usually several stems, a bushy appearance and often branched from within 1 ft of the ground (e.g., Vaccinium corymbosum).

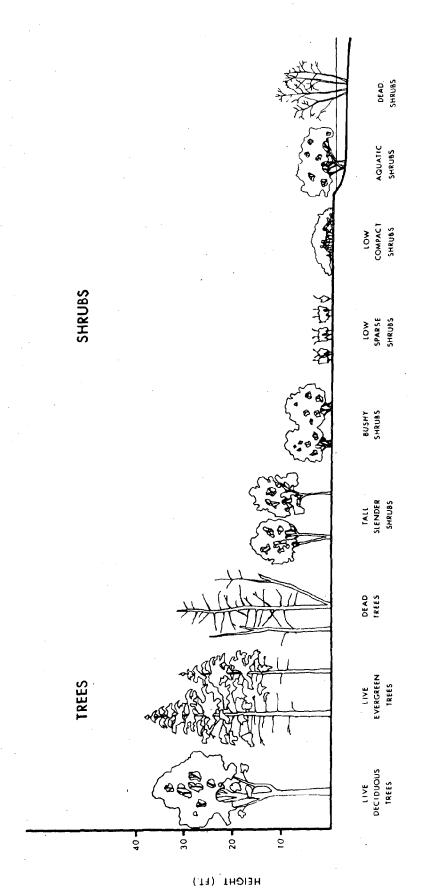
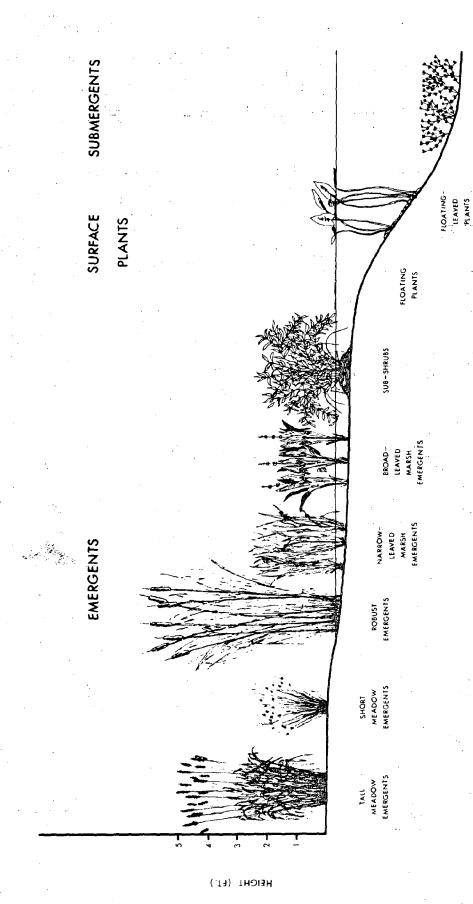


Figure 2. Sub-forms of wetland trees and shrubs.



Sub-forms of wetland emergents, surface plants and submergents. Figure 3.

SUBMERGENTS

6. Low compact shrubs. Non-aquatic shrubs less than 4 ft tall, having usually several stems, very dense foliage, and often branched from within 6 in of the ground (e.g., Myrica gale).

7. Low sparse shrubs. Non-aquatic, simple or sparsely branched shrubs

up to 3 ft tall (e.g., Spiraea tomentosa).

8. Aquatic shrubs. Shrubs up to 7 ft tall, growing in standing water 6 in or more deep (e.g., Cephalanthus occidentalis).

9. Dead shrubs. Standing dead shrubs and tree stumps less than 5 ft tall.

EMERGENTS (6 sub-forms). Rooted herbaceous or semi-woody plants that have the majority of their vegetative portion above the water surface. This includes herbaceous plants growing on moist, but exposed soil.

10. Sub-shrubs. Emergents up to 5 ft tall with herbaceous, arching stems; a persistent semi-woody base; and growing in water up to 18 in deep (e.g., <u>Decodon verticillatus</u>).

11. Robust emergents. Stout, erect emergents 5 to 10 ft tall which persist upright during the winter and into the second spring (e.g., Typha latifolia).

12. Tall meadow emergents. Grass-like emergents up to 6 ft tall, often forming dense stands; found on moist or seasonally flooded

soil (e.g., Phalaris arundinacea).

13. Short meadow emergents. Sedge-like emergents less than 4 ft tall, some species forming tussocks; found on moist or seasonally flooded soil (e.g., Juncus effusus).

14. Narrow-leaved marsh emergents. Narrow-leaved emergents less than 5 ft tall, growing in water up to 18 in deep (e.g., Sparganium

eurycarpum).

15. Broad-leaved marsh emergents. Broad-leaved emergents less than 3 ft tall, growing in water up to 18 in deep (e.g., Pontederia cordata).

SURFACE VEGETATION (2 sub-forms). Plants with vegetative parts principally on the water surface.

16. Floating-leaved vegetation. Rooted plants with leaves floating on the water surface (e.g., Nymphaea odorata).

17. Floating vegetation. Non-rooted plants that float freely on the water surface (e.g., Lemna minor).

SUBMERGENTS (1 sub-form). Plants that lie beneath the water surface, except for flowering parts in some species.

18. Submergents. (e.g., Ceratophyllum demersum).

Wetland classes and subclasses. Wetland classes are synonymous with the following freshwater wetland types outlined by Martin et al (1953): open fresh water, deep fresh marsh, shallow fresh marsh, fresh meadow, seasonally flooded basins and flats, shrub swamp, wooded swamp and bog. Seasonally flooded flats are restricted to river floodplains, whereas they also include upland basins in the Martin et al. (1953) system. A wetland subclass is one of two or more types of wetlands of the same class that differ significantly in their wildlife value, chiefly because of differences in dominant sub-forms of vegetation. The subclasses below are those most common in Massachusetts. Additional subclasses can be named simply by using a sub-form name to modify a class name; e.g., sub-shrub shallow marsh.

OPEN WATER (OW). This class applies to water 3 to 10 ft deep, associated with any of the other wetland classes, but usually with deep or shallow marshes. Submergent and surface vegetation are dominant.

Vegetated open water (OW-1). Surface vegetation is present. Submergents that reach to within 6 in of the surface may be present.

Non-vegetated open water (OW-2). Surface vegetation and near-surface submergents are absent.

DEEP MARSH (DM). This class applies to wetlands with an average water depth between 6 in and 3 ft during the growing season. Emergent marsh vegetation is usually dominant, with surface and submergent plants present in open areas. Dead woody deep marsh (DM-1). Standing dead trees (sub-form #3), dead shrubs or stumps (#9) are the most abundant form of cover. Shrub deep marsh (DM-2). Aquatic shrubs (#8) are the dominant form of cover. If shrubs cover less than 50 percent of the area, the wetland is classified shrub deep marsh. It is classified shrub swamp (see below) if the shrub cover is 50 percent or greater. Sub-shrub deep marsh (DM-3). Decodon verticillatus (sub-form #10) is the dominant cover plant. Robust deep marsh (DM-4). Robust emergents (#11) are dominant. This is the classic deep marsh described as Type 4 by Martin et al. (1953). Narrow-leaved deep marsh (DM-5). Narrow-leaved marsh emergents (#14) are dominant. Broad-leaved deep marsh (DM-6). Broad-leaved marsh emergents (#15) are dominant.

SHALLOW MARSH (SM). This class applies to wetlands dominated usually by robust or marsh emergents, with an average water depth less than 6 in during the growing season. Surface water may be absent during the late summer and abnormally dry periods. Floating-leaved plants (#16) and submergents (#18) are often present in open areas. Robust shallow marsh (SM-1). Robust emergents (#11) are dominant. Narrow-leaved shallow marsh (SM-2). Narrow-leaved marsh emergents (#14) are dominant. Broad-leaved shallow marsh (SM-3). Broad-leaved marsh emergents ( $\frac{n}{n}$ 15) are dominant. Floating-leaved shallow marsh (SM-4). Floating-leaved vegetation (#16) dominates. This is an unusual wetland type which occurs primarily on Cape Cod. It is classified shallow marsh since the average water depth is less than 6 in. Most of the surface water is gone by late summer, leaving water lilies lying on exposed mud. Emergent plants occur only in sparse stands on the periphery.

SEASONALLY FLOODED FLATS (SF). This class applies to extensive river flood-plains where flooding to a depth of 12 or more inches occurs annually during late fall, winter and spring. During the summer, the soil is saturated, with a few inches of surface water occurring locally. Dominant vegetation usually is emergent, but shrubs and scattered trees may be present.

Seasonally flooded emergent flats (SF-1). Meadow emergents (#12, 13) dominate, with robust (#11) and marsh emergents (#14, 15) occurring in wetter places, particularly along the stream. Bushy (#5) and aquatic shrubs (#8) are often found near the stream as scattered across the

floodplain. This subclass resembles an ungrazed meadow (M-1, below) except for its greater size, its floodplain location and its generally deeper surface water during the spring.

Seasonally flooded shrub flats (SF-2). Aquatic (#8) and bushy (#5) shrubs are dominant. Low sparse shrubs (#7) are sometimes abundant. Ground cover is largely sedges and grasses like those that dominate the previous subclass. Shrub flats are similar in appearance to bushy shrub swamps (SS-2) and aquatic shrub swamps (SS-4) except for their floodplain location and their generally deeper surface water during the spring.

MEADOW (M). This class applies to wetlands dominated by meadow emergents (#12, 13), with up to 6 in of surface water during the late fall, winter and early spring. During the growing season the soil is saturated and the surface exposed, except in shallow depressions and drainage ditches. Meadows occur most commonly on agricultural land where periodic grazing or mowing keeps shrubs from becoming established. The structural differences in meadow vegetation often result from grazing; therefore, meadows have been divided into grazed and ungrazed subclasses. Ungrazed meadow (M-1). The effects of grazing are absent. By early summer, most ungrazed meadows support dense, unbroken stands of tall meadow emergents (#12); short meadow emergents (#13) and broad-leaved herbs are often present, but rarely dominant. This subclass occurs in two major locations: on agricultural land and on the floodplains of small streams. In the latter site, the meadows resemble miniature seasonally flooded flats. Grazed meadow (M-2). Cover plants are greatly modified as a result of grazing. Certain plants such as Juncus effusus and Spiraea tomentosa persist while most of the grasses and sedges are selectively removed.

SHRUB SWAMP (SS). This class applies to wetlands dominated by shrubs where the soil surface is seasonally or permanently flooded with as much as 12 in of water. Carex stricta is the characteristic ground cover beneath shrubs. Meadow (#12, 13) or marsh emergents (#14, 15) occupy open areas. Sapling shrub swamp (SS-1). Tall slender shrubs (#4) are dominant. The term "sapling" is used because the most common woody species in this subclass is Acer rubrum. Large Alnus rugosa, although technically not a sapling, is the second most common species. Bushy shrub swamp (SS-2). Bushy shrubs ( $\frac{4}{17}$ ) are dominant. Compact shrub swamp (SS-3). Compact shrubs (#6) are dominant. Stands of Chamaedaphne calyculata are excluded because this species typically grows on peat, in bogs, rather than on mineral soil or muck, the characteristic substrate of swamps. Aquatic shrub swamp (SS-4). Aquatic shrubs (#8) are dominant. They cover more than 50 percent of the wetland area (cf. DM-2). Aquatic shrub swamps contain surface water longer and of greater depth than other shrub swamp subclasses.

WOODED SWAMP (WS). This class applies to wetlands dominated by trees. The soil surface is seasonally flooded with up to 1 ft of water. Several levels of vegetation are usually present, including trees, shrubs and herbaceous plants. In mature wooded swamps, microtopography is very pronounced. Trees and many shrubs grow on well developed windthrow mounds while marsh emergents and ferns occupy the vernal pools.

Deciduous wooded swamp (WS-1). Deciduous trees (#1) are dominant. Evergreen wooded swamp (WS-2). Evergreen trees (#2) are dominant. Sphagnum often covers the ground in wetter areas, but the soil is muck rather than peat.

BOG(BG). This class applies to wetlands where the accumulation of Sphagnum moss, as peat, determines the nature of the plant community. Young bogs commonly have floating peat mats which creep outward from shore over the surface of open water. Northern New England bogs resemble those of the Boreal Forest region. Picea mariana and Larix laricina are characteristic tree species. In southern New England bogs especially those in the coastal zone, Chamaecyparis thyoides is dominant. Chamaedaphne calyculata, Kalmia angustifolia, Sarracenia purpurea, and Eriophorum spp. are characteristic plants found in bogs throughout the northeast. A bog often can be divided into at least five zones (Moizuk and Livingston, 1966): open water, bog mat (Sphagnum and sedges), low shrubs, high shrubs and trees. In Massachusetts, bogs dominated by low shrubs or by trees are most

Shrub bog (BG-1). Low, compact shrubs (#16) are dominant.

Wooded bog (BG-2). Evergreen trees (#2) are dominant. Acer rubrum is usually present, but seldom does it reach maximum size on the peat mat.

Size categories. Wetlands in the glaciated northeast range from less than lacre to several thousand acres in size. The size categories devised apply to individual wetlands as typed on aerial photographs. In interpreting the influence of size on a wetland's wildlife value, both the size and the juxtaposition of the wetland with others in a complex must be considered. The following size categories were devised for use in statewide or regional planning. In a more localized area, a 50-acre wetland might be considered "large."

#### Size categories:

- 1. Very Small -- less than 10 acres
- 2. Small -- 10-50 acres
- 3. Medium-sized -- 51-100 acres
- 4. Large -- 101-500 acres
- 5. Very Large -- greater than 500 acres

Site types. Site type is a wetland descriptor based upon topographic and hydrologic location. Topographic location can be broadly categorized as either upland or bottomland. Upland sites lie above alluvial or outwash plains, above stream valleys and floodplains. Most upland wetlands occur on bedrock, on till or on small pockets of outwash overlying till; the water table is usually perched. Bottomland sites lie chiefly on the alluvium of stream floodplains, on outwash plains or on glacial lake deposits. Perched water tables may occur, but regional water tables are the rule.

A wetland's hydrologic location may be lakeside, streamside, deltaic or isolated. To be isolated, the wetland must not border any larger body of open water. Small streams may course through it, but the wetland is obviously not subordinate to the streams. Isolated wetlands usually owe their wetness as much to groundwater seepage and surface runoff as to stream-flow. Streamside wetlands occur along a large stream and occupy part of all of its floodplain. A lakeside wetland occurs on the margin of a lake. A deltaic wetland lies at the point where a stream enters a lake.

#### Site types:

- 1. Upland -- isolated
- 2. Upland -- lakeside
- 3. Bottomland -- isolated
- 4. Bottomland -- lakeside
- 5. Bottomland -- streamside
- 6. Bottomland -- deltaic

Cover types. The relative proportions of cover and open water and their degree of interspersion are two of the most vital features affecting wildlife value (Williams and Marshall, 1938; Mendall, 1958; Weller, 1964; Weller and Spatcher, 1965; McGilvrey, 1968). Collectively these features constitute the cover type, a term coined by Stewart and Kantrud (1971). In their system, where each wetland usually consists of one wetland class, "cover" refers to stands of plants on the periphery of, or interspersed with, areas of open water. I have expanded their concept considerably to fit the northeastern wetland which often consists of several wetland classes. In this system cover type is determined from aerial photographs with field checking.

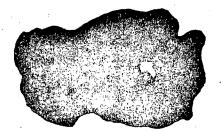
"Cover" can include entire wetland classes (e.g., wooded swamp, shrub swamp) as well as stands of individual plants. "Open water" consists of the class open water (OW) and the smaller open portions of marshes and bogs. Stewart and Kantrud (1971) recognized four cover types; I have outlined eight. They are diagrammed in Figure 4 and described below.

#### Cover types:

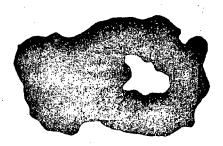
- 1. Cover occupies more than 95 percent of the wetland area.
- 2. Cover occupies 76-95 percent of the wetland area, occurring in a peripheral band.
- 3. Cover occupies 76-95 percent of the wetland area, occurring in dense patches or diffuse, open stands.
- 4. Cover occupies 26-75 percent of the wetland area, occurring in a peripheral band.
- 5. Cover occupies 26-75 percent of the wetland area, occurring in dense patches or diffuse, open stands.
- 6. Cover occupies 5-25 percent of the wetland area, occurring in a peripheral band.
- 7. Cover occupies 5-25 percent of the wetland area, occurring in patches or diffuse, open stands.
- 8. Cover occupies less than 5 percent of the wetland area.

Vegetative interspersion types. Since most wildlife species require more than one structural type of vegetation, their population density depends partly on the presence and length of certain kinds of edge. In this context, edge refers to the line of contact between two different sub-forms of vegetation. Whereas wildlife numbers are closely related to the total length of edge, wildlife diversity is a function of the number of kinds of edge. Small sub-form stands have more edge per unit of area than larger stands. For wetland evaluation, I recommend a minimum size of 1 acre for recognition of a sub-form stand. Since long, narrow strips of vegetation, like those that flank streams, are extremely significant to wildlife, these should be considered during evaluation, even though the total area of such a strip might be far less than 1 acre.

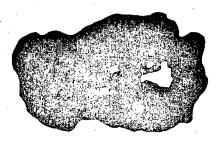
Figure 4. Wetland cover types. White areas indicate water (with or without surface plants); black areas indicate emergents, shrubs or trees.



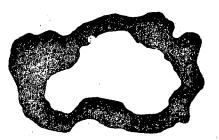
COVER TYPE 1



COVER TYPE 2



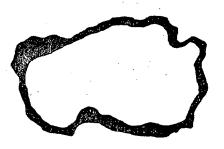
COVER TYPE 3



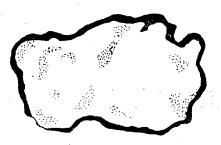
COVER TYPE 4



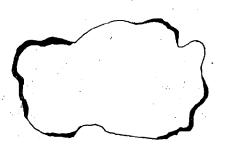
COVER TYPE 5



COVER TYPE 6



COVER TYPE 7



COVER TYPE 8

Figure 5 illustrates three wetlands which contain the same number of life forms (three) and sub-forms (six), but which represent different vegetative interspersion types. The number of kinds of edge associated with each type is just an example; it is not the characteristic number for that type.

#### Vegetative interspersion types:

- 1. Low Interspersion -- Length and types of edge are at a minimum. The wetland consists of concentric life form and sub-form zones or a single sub-form. Sub-form stands are large and unbroken.
- 2. Moderate Interspersion -- Edge is moderate in length and diversity. There is some irregularity in the distribution of sub-form stands, but life form zones remain largely intact.
- 3. High Interspersion -- Edge is abundant and consists of many kinds. Life form zones are broken into segments of variable size and shape. Sub-form stands are small and scattered.

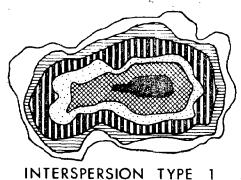
Surrounding habitat types. The nature of the surrounding habitat is a key feature determining a wetland's wildlife value. Waterfowl and most other wetland wildlife depend upon suitable surroundings for food and nest sites. The surrounding habitat types also determine what upland species are likely to use the wetland. Furthermore, intense human activity adjacent to a wetland can deter many species from utilizing the wetland. Surrounding "natural" habitat may serve as a buffer, reducing disturbance of wildlife and satisfying some of their requirements. The broad surrounding habitat types below were adopted from a land use cover-typing system developed by MacConnell and Pywell (1969):

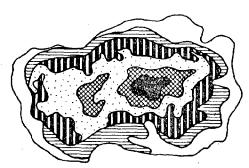
- 1. Agricultural or Open Land
- 2. Forest Land
- 3. Salt Marshes
- 4. Mining or Waste Disposal Areas
- 5. Urban Land
- 6. Outdoor Recreation Facilities

Additional descriptive components. The components described so far represent the most important ecological features determining a wetland's wildlife value. Two other components, wetland juxtaposition and water chemistry, are useful in wetland evaluation (see next section) but are not employed in classification.

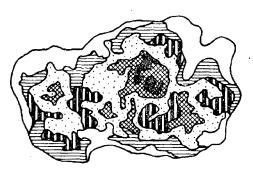
#### Criteria for Wetland Evaluation

Once a wetland has been classified, evaluation is straightforward. Table 1 contains ten criteria and a relatively simple rating system. Each criterion has specifications describing three or more possible categories into which a given wetland might be placed. Specifications have been assigned ranks, ranging from 3 (highest value) to 1 (lowest value). During evaluation a wetland receives a rank for each of the ten criteria. If, for any criterion, more than one specification seems to fit the wetland, the ranks for those specifications are averaged. Since some criteria are more important than others, each has been given a fixed numerical value, called a significance coefficient, ranging from 5 (most important criteria) to 1 (least important





INTERSPERSION TYPE 2



INTERSPERSION TYPE 3

DECIDUOUS TREES TALL MEADOW EMERGENTS TALL SLENDER SHRUBS ROBUST EMERGENTS BUSHY SHRUBS BROAD-LEAVED EMERGENTS

Figure 5. Examples of the three wetland vegetative interspersion types: Type 1 -- minimum length of edge, large units and few types of edge (five in this example). Type 2 -- moderate length of edge, medium-large units and moderate number of types of edge (seven in this example). Type 3 -- great length of edge, small units and many types of edge (eleven in this example).

Wildlife criteria, significance coefficients, specifications and ranks. Table 1.

|          | Rank                              | (3.0)   | (2.5)             | (2.0)                              | (1.5)             | (1.0)                |
|----------|-----------------------------------|---|-------------------|------------------------------------|-------------------|----------------------|
| •        | Criteria.                         |   | Specifications    | ions                               |                   |                      |
|          | Wetland Closs<br>Richness $(5)^1$ | 5 or more<br>classes  | 4 classes         | 3 classes                          | 2 classes         | l class              |
|          | Lominant Wet-<br>land Class (5)   | SF, DM  | NS                | WS, SS                             | OW, BG            | M                    |
| <i>:</i> | Size Category (5)                 | over 500 acres  | 101-500 acres     | 51-100 acres                       | 10-50 acres       | under 10 acres       |
|          | Subclass<br>Richness (4)          | 10 or more<br>subclasses  | 6-9<br>subclasses | 4-5<br>subclasses                  | 2-3<br>subclasses | l<br>subclass        |
| •        | Site Type $(\mu)$                 | bottomland -<br>lakeside<br>bottomland -<br>deltaic<br>bottomland -<br>streamside | <u> </u>          | bottomland - isolated bottomland - |                   | upland -<br>isolated |

l Number in parentheses after each criterion is its significance coefficient.

Table 1. (Continued)

| Wetland Juxta- position (2)   | Criteria       | Rank  |
|---|----------------|-------|
| Hydrologically connected to other wetlands (different dom. class) or open water bodies within 1 mile.  Hydrologically connected to other wetlands (same dom. class) within 1/4 mile.  (or)  Wetland greater than 500 acres, with three or more wetland classes (including DM or SM).  |                | (3.0) |
|   | Specif         | (2.5) |
| Hydrologically connected to other wetlands (different dom. class) or open water bodies from 1-3 miles away.  (or) Hydrologically connected to other wetlands (same dom. class) from 1/4-1 mile away.  (or) Within 1/2 mile of other wetlands (different dom. class) or open water bodies, but not hydrologically connected. | Specifications | (2.0) |
|   |                | (1.5) |
| All other   |                | (1.0) |

Table 1. (Continued)

| Vegetative<br>Interspersion<br>Type (3) | Cover Type (3)             | Criteria Surrounding Habitat Types (4)   | Rank  |  |
|---|----------------------------|--|-------|--|
| Type 3                                  | Type 5                     | 2 or more of following con- stitute more than 90% of surrounding habitat: 1. forestland 2. agricultural or open land 3. salt marsh   | (3.0) |  |
|   | Type 4                     | Specifications  1 or m  lowin 50-90 habit 1. fo 2. ag o 3. sa 1 of p stitu 90% o habit   | (2.5) |  |
| Type 2                                  | Type 3<br>Type 7           | ations  l or more of following constitute 50-90% of surrounding habitat:  l. forestland 2. agricultural or open land 3. salt marsh (or) l of preceding constitutes more than 90% of surrounding habitat. | (2.0) |  |
|   | Type 1<br>Type 2<br>Type 6 | g ing  | (1.5) |  |
| Type 1                                  | Type 8                     | l or more of following constitute less than 50% of surrounding habitat:  1. forestland 2. agricultural or open land 3. salt marsh  | (1.0) |  |

£4.3

11

Table 1. (Continued)

| Kark | (3.0)  | (2.5) | (2.0)   | (1.5) | (1.0)   |
|------|--|-------|---|-------|---|
|      |  |       | Specifications  |       |   |
| (1)  | Mater Chemistry (1) Total Alkalinity<br>greater than 69<br>ppm CaCO <sub>3</sub> . |       | Total Alkalinity $23-69 \text{ ppm } \text{CaCO}_3$ . |       | Total Alkalinity<br>less than 23<br>ppm CaCO <sub>3</sub> . |
|      | pH greater than 7.5  | 10    | ph 6.5-7.5  |       | pH less than 6.5  |

criterion). A sub-score is calculated for each criterion by multiplying the significance coefficient for that criterion by the rank given. Scores for all criteria are summed and a total wetland score is obtained. This final score represents, in simple quantitative fashion, the wetland's relative wildlife value. Table 2 illustrates the scoring procedure for an imaginary wetland.

Table 2. Wetland scoring (ranks are based on fictitious data).

| Criterion              | Significance<br>Coefficient | Rank | Subscore |
|------------------------|-----------------------------|------|----------|
| 1. Class Richness      | 5                           | 2.0  | 10.0     |
| 2. Dominant Class      | 5                           | 3.0  | 15.0     |
| 3. Size                | 5                           | 2.5  | 12.5     |
| 4. Subclass Richness   | ĹĻ                          | 2.5  | 10.0     |
| 5. Site Type           | 4                           | 2.0  | 8.0      |
| 6. Surrounding Habitat | 4                           | 3.0  | 12.0     |
| 7. Cover Type          | 3                           | 2.0  | 6.0      |
| 8. Veg. Interspersion  | 3                           | 1.0  | 3.0      |
| 9. Juxtaposition       | 2                           | 2.0  | 4.0      |
| LO. Water Chemistry    | 1                           | 3.0  | 3.0      |
| Total Wetland Score    | *                           |      | 83.5     |

The lowest possible total score is 36 and the highest is 108. This implies, and rightly so, that even the least valuable wetland has some wildlife value. For some criteria there are five categories of specifications and five corresponding ranks (3.0, 2.5, 2.0, 1.5 and 1.0). For other criteria, where our knowledge or measurement ability is less refined, only three categories of specifications and ranks (3.0, 2.0, 1.0) are recognized. A brief description of each of the criteria follows.

- 1. Wetland class richness. This criterion describes the number of wetland classes present in a wetland, where 5 acres is the minimum area recognizable as a separate class. As class richness increases, so does the likelihood for greater wildlife species richness. Wetland class richness is the broadest and single most important criterion for evaluation.
- 2. Dominant wetland class. Some wetland classes have greater value than others for wildlife diversity and production, and certain classes provide the only suitable habitat for some species highly valued by man (e.g., waterfowl). Dominant life form of vegetation, water depth and permanence of surface water are the major characteristics considered in ranking classes (see Table 1). The dominant class is the one that clearly occupies the greatest area. If two or more classes are co-dominant, the ranks are averaged.

- 3. <u>Size categories</u>. Wetlands are ranked from largest to smallest, according to the general principle that as size increases, so does wildlife value. Greater size usually results in greater insulation from human disturbance, greater habitat diversity and greater wetland longevity. In addition, wetlands larger than 100 acres are of great value to flocks of migrating waterfowl.
- 4. Subclass richness. This variable goes one step further than wetland class richness in assessing habitat diversity. Just as particular life forms characterize classes, particular sub-forms characterize subclasses. A wetland's broad wildlife value increases as the number of subclasses increases. As noted above, a wetland segment must be at least 1 acre in size to be recognized as a separate subclass.
- 5. Site type. Bottomland wetlands are generally more valuable than upland wetlands because of greater soil fertility, more sustained surface water levels and greater life expectancy. Similarly, wetlands associated with open water bodies are usually more valuable than isolated ones. Using this rationale I grouped site types into three categories for evaluation (see Table 1).
- 6. Surrounding habitat types. Freshwater wetlands bordered by forest, agricultural or open land, or salt marsh are more valuable to wildlife than those adjacent to land more intensively developed by man. Furthermore, diversity in the surrounding habitat increases the possibility of wildlife diversity within the wetland. The percentage of the surrounding habitat types present determine the rank given for this criterion.
- 7. Cover type. This variable can be assessed in wetlands consisting of one or many wetland classes, although its value is most evident in evaluating deep and shallow marshes. Studies (Weller and Spatcher, 1965; McGilvrey, 1968) suggest that a cover-water ratio of approximately 50:50 is optimal for waterfowl and marsh birds in general. Highest ranks are thus given to wetlands with nearly equal proportions of cover and water. Areas with nearly total cover or total open water receive low ranks. In addition, cover interspersed with water is deemed more valuable than a band of cover surrounding open water.
- 8. Vegetative interspersion. A wetland receives a rank for this criterion according to which interspersion type (Figure 5) it approximates. High ranks are associated with an abundance of edge between sub-form stands, small size of such stands and a large number of different kinds of edge.
- 9. Wetland juxtaposition. A wetland's value is generally higher if it is located near other wetlands, expecially if the adjacent wetlands contain classes or subclasses different from those of the wetland being evaluated. Moreover, the value increases if these wetlands are interconnected by streams. In such cases, wildlife (especially waterfowl) can move safely between wetlands to best meet their habitat requirements. The ranking of specifications listed in Table 1 reflects these considerations.

10. Water chemistry. Water chemistry influences the presence, abundance and distribution of aquatic plants and invertebrates (Juday, 1942; Moyle, 1945, 1946; Jahn and Hunt, 1964). Decision-makers have no time to adequately sample and describe wildlife food plants and animals, but water chemistry determinations can serve as indices of potential productivity. Brooks and Deevey (1963) pointed out that New England surface waters are very dilute and extremely soft for the most part. Analysis of water chemistry data provided by the Massachusetts Division of Fisheries and Game produced support for this generalization. These data suggest that average total alkalinity in excess of 70 ppm CaCO<sub>3</sub> and pH values above 7.5 can be considered high. Specifications for pH (Table 1) are based upon clear-cut groupings of the graphed data for 95 ponds and lakes. Alkalinity specifications derive from classes of Brooks and Deevey (1963). Total alkalinity is the better index of productivity; pH is less reliable, and should only be used if alkalinity data are not obtainable.

### Discussion

This system of wetland classification and evaluation allows one to objectively group wetlands according to their wildlife value and to identify key areas for preservation and acquisition. Use of the system assumes, however, acceptance of the stated standard for evaluation: maximum wildlife production and diversity. The above criteria would not be suitable for use by a state fish and game agency attempting to identify valuable wood duck (Aix sponsa) production areas. For that case, more specialized criteria would be required.

Two major constraints guided the development of this system. First, it was designed for use by decision-makers. A special effort was made to produce criteria that are as uncomplicated and objective, and yet as sensitive, as possible. The necessary data for most of the evaluation can be obtained from recent aerial photographs, topographic maps and surficial geology maps. Wetland subclass, vegetative interspersion and water chemistry are key descriptors which require unavoidable, but limited, field work. Shortage of time and expertise would render a more sophisticated system useless to the decision-maker.

The choice to consider virtually all wildlife species during evaluation imposed another major constraint. Although wildlife production and diversity are both reasonable goals, they are not strictly compatible. It is impossible to maximize the production of all species at once, since each has a different set of habitat requirements. The broadness of the criteria reflect the overriding influence of compromise.

Certain wetlands possess characteristics that render them unique or of outstanding value. For example, a wetland might support the only nesting colony of black-crowned night herons (Nycticorax nycticorax) in an entire state. Such a wetland merits preservation, even though it might not score highly by this system. Clearly, some subjective decisions must be made.

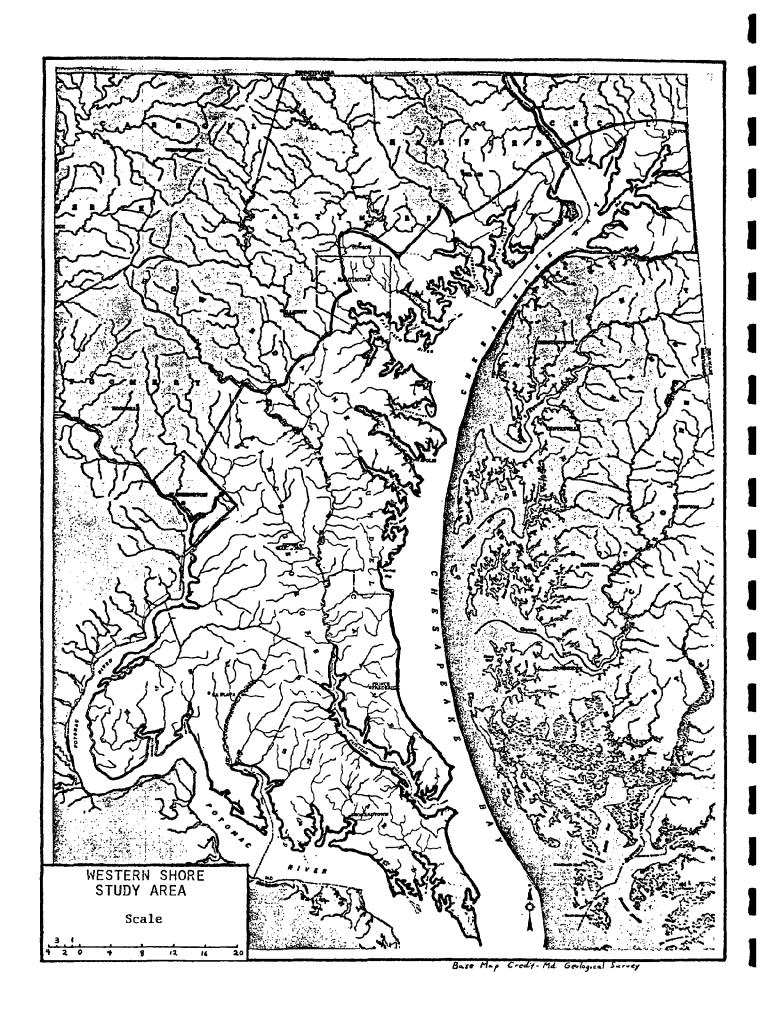
Similarly, after a wetland has been scored by this system, other subjective considerations are in order. What human impacts are operating on the wetland, and to what extent do these depress the total score? In some cases, proper control of land use practices can raise significantly a wetland's wildlife value. Secondly, what is the wetland's potential for enhancement via habitat manipulation? Two wetlands with identical scores might be differentiated according to their potential for enhancement. This potential depends on such factors as topographic and hydrologic location.

Above all, the value of any wetland must be viewed in its proper context. The absolute value of a score is meaningless; the score has meaning only in relation to the scores of other wetlands. All wetlands in Amherst, Massachusetts might be evaluated and their scores compared. The "average" score would undoubtedly vary from the "average" score in Worcester or Provincetown since wetland characteristics are greatly influenced by physiography and land use. Any attempt at the use of cut-off scores in decision-making must be sensitive to the importance of the scale of reference.

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# STUDY AREA

The Upland Natural Area Study is confined to the Maryland counties bordering the Western Shore of the Chesapeake Bay, the Potomac River up to the District of Columbia, and Cecil County. The inland boundary of the study essentially follows a line corresponding to Interstate 95. The study is therefore limited to areas lying within Maryland's Coastal Plain.

Maryland's Coastal Plain falls within the northern embayed portion of the Atlantic Coastal Plain physiographic province. This embayed portion of the Coastal Plain is characterized primarily by the presence of drowned river systems and barrier beaches (ocean coast). The Bay itself represents the drowned portion of the Susquehanna River and its tributaries.

The rolling uplands of the Western Shore Coastal Plain are generally bounded by deep stream valleys. These uplands are underlain by a series of southeasterly dipping layers of relatively unconsolidated sand, clay and gravel. These sediments range in age from early Cretaceous to Holocene and represent deposition in a variety of marine environments. Fossils are abundant in many of these formations particularly in the Calvert Cliffs area. (The first fossil to be described in North America came from these formations.)

Nine major soil associations occur in the study area. Because of the nature of the parent material these soils are usually sandy and often have significant amounts of silt and clay mixed in. Medium to moderately course textured soils predominate throughout the Western Shore. Of note are the Beltsville soils which cover much of Southern Maryland. These soils are characterized by a deep, compact fragipan lying below the soil surface. This layer inhibits both water movement and root penetration often causing the vegetation in these areas to represent types associated with arid regions. Othello soils, found throughout the Coastal Plain, develop on the fine silts of lowlands deposits and, therefore, are generally found in level, flat areas bordering the Bay and its tributaries.

Mixed hardwood forests originally covered most of the Western Shore uplands. These forests are characterized by oaks, hickories, maples, beech and gum. Dogwood, sassafras and holly are characteristic understory species. Because of intensive agricultural practices and logging, few remnants of Maryland's original forests remain. Typical forest stands today are second and third growth stands. This extensive clearing also accounts for the increase in the percent of pine forests through out the region. The pines represent an early successional stage which is often maintained because of continued disturbance. Typical pine species include Scrub Pine (Pinus virginiana) and Loblolly Pine (Pinus taeda) (Shreve, et al, 1910).

Two vegetation associations can be considered lowland areas, the Gum-Pine association and river swamps. The Gum-Pine association is characterized by Sweet Gum (Liquidambar styraciflua) and Loblolly pines along with red maples and several oaks. The river swamps occur along the flood plain of the rivers. The best example of this vegetative community

is Zekiah swamp running along the Wicomico River in Charles County. The dominant trees of this association are Sweet Gum, River Birch, and Swamp Oaks. Southern Maryland lies just within the range of the Bald Cypress (Taxodium distichum) which is represented in a large swamp in Southern Calvert County (Shreve, et al, 1910).

Extensive marshes are found bordering the rivers of Maryland. These grade from typical salt marshes in the lower stream reaches to fresh marshes further upstream and in the northern portions of the Bay. These marshes play an important role in buffering the stream banks from the waves washing against the shore as well as trapping sediments washed from the uplands. Typical species range from Spartina, Scirpus and Juncus for salt marshes to Typha, Potamogeten, and Numphaea in fresh marshes.

#### Aquatic Buffer Zone

Owing to its importance to the Coastal Zone Management Program, various aspects of the aquatic buffer zone are extensively detailed below.

In recent decades, the degradation and loss of aquatic systems has underscored the need for sound ecological management of streams, ponds and wetland. Increased public awareness of the relationship of land use, water quality, and aquatic life led to the enactment of the Coastal Zone Management Act of 1972 as well as to passage of the 1972 amendments to the Federal Water Quality Act. Such legislation provides the potential for environmental protection through responsible State action.

As mandated in Section 205 of the Coastal Zone Management Act of 1972, states are required to delineate areas of particular concern and indicate permissible land uses. Sites with rare or otherwise important species and physical features are candidates for designation as areas of concern.

Within all sites containing water courses or water bodies, a critical zone of land exists between the water and the neighboring upland. This zone is of particular concern because it is both fragile and, under natural conditions, acts as a buffer to the aquatic system. Throughout the coastal zone, buffers play a variety of roles. They are of primary importance in protecting aquatic systems against impacts accompany agriculture and development, which include sediment, toxic chemicals such as herbicides and pesticides, fertilizers, nutrients, oils and bacteria. In addition, this zone detains runoff and controls erosion on streamside slopes. These vegetated buffers provide a visually diversified landscape and contribute to environmental quality by providing wildlife shelter, nesting sites and food.

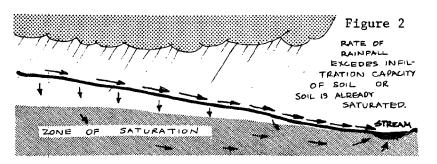
The present land use pattern of the Eastern Shore contains many lush stream side forests of sufficient width to serve important protective functions with respects to aquatic biota. The natural vegetation in these buffer zones maintains the health of the aquatic system by (1) maintaining a balanced nutrient regime, (2) moderating water temperatures by shade, (3) providing aquatic organisms with food sources, (4) reducing the scouring of stream bottoms and (5) preventing sedimentation through control of runoff and erosion. Thus, when retained in a natural condition, buffer zones serve as maintenance-free "public works projects". Once destroyed, these amenities and their services are lost and are difficult, if not impossible, to replace at reasonable cost. Functionally equivalent benefits can only be attained by public expenditures for water filtration, dredging, recurrent stocking of streams with fish, flood control programs and the creation of artificial wildlife habitats. Natural amenities are irreplaceable.

The following discussion outlines the key features considered in the identification of aquatic buffers and in ascertaining adequate buffer widths under varying conditions. First is described the key physical processes which occur along water bodies and watercourses, these are then related to appropriate buffer widths. A discussion of possible compatible uses is included. This discussion is detailed to provide decision makers with a thorough understanding of the processes and considerations involved in determining adequate widths for aquatic buffer zones.

#### Runoff

When rain strikes the ground it can dislodge soil particles and transport this sediment, as well as any oil residues, pesticides, fertilizers, to watercourses. In general, it is the properties of the soil which determine whether the rain will infiltrate into the ground or move overland as runoff to the aquatic system. If the rate of rainfall is greater than the capacity of the soil to absorb it, or if the soil is already saturated, the unabsorbed excess becomes overland flow, and the water and its contents can reach the aquatic system.

If the precipitation is absorbed by the soil it may move toward the surface water system by a variety of pathways. If the soil is deep and of fairly uniform permeability, the subsurface water moves downward to the zone of saturation and then flows within the soil to the nearest watercourses. (Dunne, 1974).



# OVERLAND & GROUND FLOW

IN HOMOGENOUS SOIL

RUNDER TRANSPORTS SEDIMENT, NUTRIENTS, AND TOTIC CHEMICALS TO AQUATIC SYSTEMS.

Soils or rocks with varying properties may complicate this simple pattern (Davis and Dewiest, 1966). Generally, ground water flows slowly, and the underground paths of flow are long. Therefore, most underground flow contributes only to the stream's baseflow, the basic stream flow to which storm water is an addition.

If percolating water encounters an impeding horizon (claypan or fragipan) in the subsoil, at some shallow depth part of the water will be diverted horizontally over the impeding layer and will reach the watercourses sooner by a shorter path. This diversion through the soil, often along the impeding surface, is called <u>sub-surface</u> flow, and is one form of the general ground flow. (Dunne, 1974).

Where water follows this shorter path or where steeper slope gradients occur, water may reach the stream channel more quickly than by typical ground-water flow and may contribute to the storm peak-flow of the stream (Weyman, 1970, Ragan, 1968). On some slopes, sub-surface flow may intersect the ground

surface and emerge as a spring or seep. The water then traverses the surface of a saturated area as return flow (Dunne, 1974).

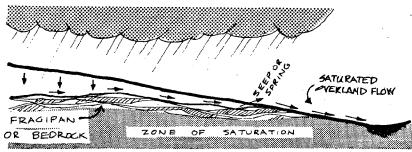


Figure 3 SUB-SURFACE, RETURN, AND SATURATED OVERLAND FLOWS

Rain falling directly onto saturated soils near streams cannot infiltrate into the wet soil, but runs over the surface to the stream channel. This is termed <u>saturated overland flow</u>. It is impossible to separate saturated overland flow from return flow and the two together are usually considered saturated overland flow (Dunne, 1974).

#### Partial Areas

The occurrence of each water flow process is a function of geology, physiography, soil properties, vegetation and land use in a particular region. Recent studies of undeveloped watersheds in the eastern United States and in England have shown that a saturated area adjacent to streams contributes the greatest runoff volume during storms. A number of investigations (Table 3) support the idea that most overland flow occurs from areas that make up no more than 10%, and usually only 1-3% of a drainage basin (Dunne and Black, 1971). Betson (1964) first discussed these areas when he realized that only partial areas of entire basins in the Tennessee Valley could be contributing runoff to storm flow. Hence, he coined the term "partial area" for these saturated, often shallow, stony, or compacted areas. This modifies the classic theory of Horton (1933) which implies that most rainfall events exceed the infiltration capacity of the soil and that overland flow is commonly widespread in area.

Partial areas are dynamic, expanding and contracting seasonally and with variations in storm duration and intensity. When expanded during storms, the outer edge of these areas can be considered the outer edge of the functional aquatic system. Under dry conditions the areas contract. In general, partial areas parallel the water's edge, but their shape and size is dependent on local geology, soils, relief, vegetation and land use. At a minimum, partial areas are critical to the protection of aquatic systems. They are the natural zone of overland flow and are highly erodible.

Table 3. PROPONENTS OF PARTIAL AREA THEORY

| S.E. Forest Exp.<br>Station, 1962 | S.E.F.E.S.                                 | Postulate                               | West Virginia |
|-----------------------------------|--|---|---------------|
| Betson, 1964                      | Tennessee Valley<br>Authority              | Postulate                               | Tennessee     |
| Ragan, 1968                       | U.S. Forest Ser-<br>vice                   | Field Study                             | Vermont .     |
| Dunne and Black,<br>1971          | McGill & Cornell<br>Universities           | Field Study                             | Vermont       |
| Chiang, 1971                      | D.E.P. Penn.                               | Computer Model (Pers. comm.)            | Pennsylvania  |
| Hills, 1971                       | Bristol Univ.                              | Field Study                             | England       |
| Freeze, 1972a,b                   | IBM, Thomas<br>Watson Research<br>Center   | Computer Model (sub-surface runoff)     | New York      |
| Grubruck and<br>Heald, 1974       | U.S.D.A. Water-<br>shed Research<br>Center | Field Study<br>(Phosphate<br>transport) | Pennsylvania  |

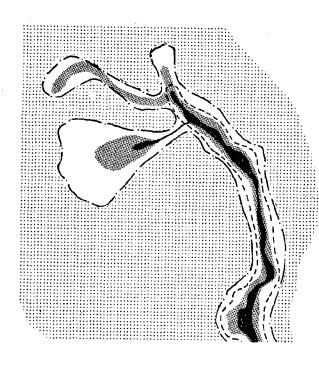


Figure 4

AREAS PRODUCING OVERLAND FLOW: IN SUMMER STORMS IN EXTREME AUTUMN STORMS AREAS WITHIN DASHED LINES PRODUCED SUB-SURFACE FLOW: IN SUMMER STORMS IN EXTREME AUTUMN STORMS SCALE IN FEET

(ADAPTED FROM THOMAS DUNNE, UNPUBLISHED PHP. THESIS, THE JOHNS HOPKINS UNIVERSITY, 1966: AREAS CONTRIBUTING RUNOFF UNDER VARIOUS STORM CONDITIONS HAPPY VALLEY BASIN NEAR DANVILLE, VT., IN: LEOPOLD, 1974, WATER, A PRIMER.)

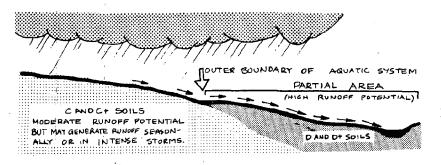
Soils are a good indicator of where partial areas are located. Chiang, (1971) has recognized that certain physical soil properties help identify the relative runoff potentials of different soils. Chiang's method of classification is an expansion of the Soil Conservation Service's Hydrologic Soils Groups, as well as a reclassification of certain soil series (Table 4).

Table 4. RUNOFF POTENTIAL RATING TABLE (Chiang, 1971)

|    |  | I                | 11  | III                 | ıv                         | ν                             | VI                | VII                       |
|----|--|------------------|---|---------------------|----------------------------|-------------------------------|-------------------|---------------------------|
|    |  | shallow<br>(18") | Well Drained<br>moderately<br>deep<br>(18"-36") |                     | Moderately<br>well drained | Somewhat<br>poorly<br>drained | Poorly<br>crained | Very<br>poorly<br>drained |
| 1. | Medium texture<br>or mixture of<br>coarse to fine<br>texture | C or (+p)***     | +c  | B or (+B)**         | +c                         | С                             | +D                | D                         |
| 2, | Coarse texture   | +C or (+D)***    | В   | +B or (A)**<br>(B)* | В                          | +C                            | <b>4-</b> p       | α                         |
| 3. | Fine texture   | C or (D)***      | С   | +C or (B)**         | C .                        | С                             | a                 | a                         |
| 4. | Medium textured<br>soil on vertically<br>fractured rock      | +C               | В   | +B                  | + C                        | С                             | +-D               | α                         |
| 5. | Coarse textured<br>soil on vertically<br>fractured rock      | В                | +B  | Α ·                 | В                          | +c                            | + D               | מֹ                        |

Revised rating for well-drained soils: \* if fragipans or clay pans exist in deep soils \*\* if the soil is deeper than 10 ft. and excessively well drained
\*\*\* if the soil is less than 9" deep

This system recognizes that shallow soils over impermeable bedrock, as well as deep soils with shallow fragipans or clay lenses, may quickly become saturated, generating runoff. This is supported by other recent studies (Hewlett and Hibbert, 1967; Hewlett and Nutter, 1970; Whipkey, 1965). Soils classified by Chiang as D and D<sup>+</sup> have high runoff potentials and are roughly equivalent to partial areas (Chiang, 1974, pers. comm.). Where these soils exist in juxtaposition to aquatic systems, they should be considered the outer boundaries of the aquatic system. In addition, C and C<sup>+</sup> soils may become saturated seasonally or during storms, and generate runoff. Although these soils generate runoff less frequently, they may be included as part of the buffer zone.



OVERLAND FLOW ON DAND D+ SOILS

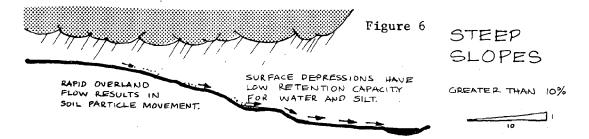
Figure 5

Several processes combine to reduce the infiltration capacity of the soil during a storm. When soils are cleared of vegetation, the filling of fine pores with water reduces capillary forces drawing water into the soil and the storage potential of the soil is more quickly reached. If clay is present in the soil, the clay particles swell as they become wet, reducing soil pore size. The impact of the raindrops, the major cause of erosion, (Young and Weirsma, 1973) breaks up soil aggregates, splashing fine particles over the surface and washing them into pores where they impede infiltration. At the beginning of a storm, percolation generally exceeds rainfall intensity and there is little accumulation of water on the soil surface. As either the intensity increases or the infiltration rate is decreased by saturation, rainfall exceeds infiltration capacity. At first, this excess rainfall fills surface depressions. When the depressions become filled the excess becomes overland flow traversing the land in a system of rills (Emmett, 1970).

Slope.

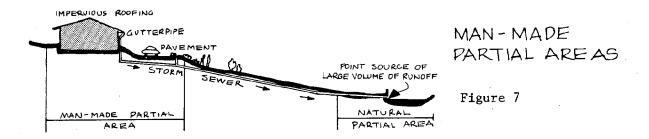
Another consideration in the protection of aquatic systems from excess runoff and siltation is the slope of the adjacent land. On slopes greater than 10 percent the slope of surface depressions is too steep to permit a significant retention of water and silt (Leopold, 1968). In fact, depending on the pattern of land management or the type of soil, surface depressions may be absent. Where denuded slopes of greater than 10 percent occur next to aquatic systems, particularly with soils having high erosion potentials, they pose a significant hazard to the aquatic system. In developing watersheds, where the soils are denuded of vegetation, the sediment yields in streams can be increased to 100 times their natural rates (Wolman, 1964).

Slopes greater than 10 percent must be carefully managed, particularly along streams, and should be kept covered with vegetation. They should be considered as part of the buffer zone depending on their proximity to the aquatic system.



#### Urbanization

In an urbanizing watershed, the path of surface water flow is largely determined by sewers, roads, rooftops and other impervious surfaces and by land uses. The two factors governing the stream flow regime are the percentage of the watershed area made impervious and the rate at which the water is transmitted to stream channels. The former is governed by the type of land use, the latter by the density, size and characteristics of tributary channels and storm sewers (Leopold, 1968). Impervious surfaces in uplands which are connected to aquatic systems by sewers are, in effect, manmade partial areas. Alternative methods for infiltrating water on site, such as pervious pavement and rooftop or other types of detention ponds, should be given serious consideration over shunting water directly to aquatic systems via sewers.



Surfaces such as lawns, pastures and trails are usually compacted and may act as impervious surface. In intense storms surfaces such as lawns become matted and runoff occurs in sheets and rills. When next to aquatic systems, they do not provide the impediment to runoff necessary for the system's protection. Vegetation undergoing natural succession is much more effective in detaining and retaining runoff.

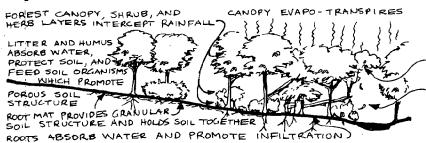
#### Vegetation

Vegetation protects the soil from raindrop impact, traps sediment, and impedes overland flow. At the same time, root systems, particularly in partial areas, absorb significant volumes of soil water during the growing season, thereby potentially increasing the infiltration capacity of streamside soils.

The foliage and roots of streamside trees such as blackgum, willow, red maple and beech are substantially more efficient than other plants at removing water from the soil (Fowells, 1965; Lee, 1942). Trees also provide litter and humus which absorb and store water. Roots which penetrate deep into the ground aerate the soil, maintaining its porosity and granular structure (Buckman and Brady, 1974). Shade from a floodplain or streamside forest moderates temperatures in the stream, thus buffering aquatic organisms

### Figure 8

## **AQUATIC BUFFERS**



### FOREST

SHADE MODERATES STREAM TEMPERATURE FLUCTUATIONS.

LEAVES BECOME FOOD AND NESTING MATERIAL FOR STREAM ORGANISMS.

SHRUBS, THICKETS, AND HERB LAYER INTERCEPT RAINFALL AND RESIST EROSION.

GRANULAR SOIL STRUCTURE, HOLDING SOIL TOGETHER-

LITTER AND HUMUS ABSORB WATER AND IMPEDE WATER VELOCITY.

SHRUB AND THICKET COVER

HERB LAYER IMPEDES WATER VELOCITY, FILTERS SEDIMENT AND NUTRIENTS, AND RESISTS EROSION.

UNDISTURBED OLDFIELD



GRASS TURF FILTERS SEDIMENT AND
IMPEDES WATER VELOCITY.

COMPACTED SURFACE
HASTENS RUNOFF

TURF MAT
HOLDS SOIL TOJETHER NUTRIENT TRANSPORT

LAWN AND PASTURE

BARE SOIL

OVERLAND FLOW CAUSES EROSION, NUTRIENT TRANSPORT, AND SILTATION OF STREAM.

AQUATIC HABITATS ARE DESTROYED

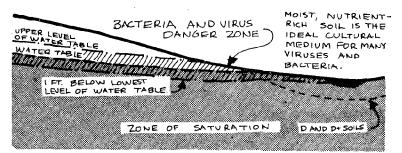
from temperature extremes. Leaf material also serves as a significant source of food and nutrient for aquatic flora and fauna (Vannote, 1975). If vegetation is removed and more sunlight allowed to penetrate the water surface, diurnal temperature fluctuations may exceed the tolerance of aquatic fauna during one or all of the life phases (Auberton and Patrick, 1965), meanwhile, the food necessary for certain organisms may be eliminated by tree removal (Vannote, 1975).

#### Biological Contamination

The soil is a rich medium for culturing both pathenogenic and non-pathenogenic bacteria. The nutrient rich, moist soils of partial areas are especially important in this respect.

Bacteria and viruses move through the soil with ground water flow. The movement of the pollution in the soil is connected with and dependent upon the rise and fall of the ground water table and the alternation of wet and dry weather conditions (Stiles and Crohurst, 1923).

The soil between the highest water table level and one foot below the lowest water table level is called the <u>bacterial danger zone</u> (Stiles and Crohurst, 1923). Here the conditions are ideal for bacterial growth. Partial areas often have a seasonal high water table at or near the surface, therefore, the bacterial danger zone is at or near the surface in these areas.



SOIL AS MICROBIAL SUBSTRATE

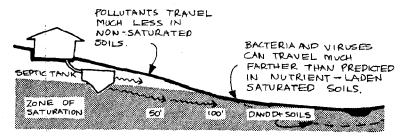
Figure 9

The properties of the soil in contact with bacterial or virulent sources play a dominant role in the subsequent life and movement of the contaminant (Caldwell, 1937, 1938). Soils which are very fine to fine grained sands with a high clay content are best suited to remove biological contamination (Romero, 1972). Bacteria in wet, nutrient rich soils have been known to survive up to five years, however, 60-100 days is probably a more common life span in temperate climates (Romero, 1972).

Many scientific studies report various sicknesses and epidemics caused by viruses traveling more than 50 feet in soil. Most controlled experiments indicate that viruses have a tendency to deteriorate within 10 feet of their source (Romero, 1972). Significant concentrations of anaerobic bacteria probably travel 50 feet according to Caldwell (1938, 1937); and Romero (1972) concludes that under ideal conditions the maximum travel distance of biological contaminants within ground water ranges from 50 to 100 feet. However, contaminant movement in non-saturated soils is considerably less than in saturated soils, with maximum lengths of travel appearing to be in the vicinity of 10 feet. Bacteria or viruses might travel considerably farther

than predicted if contaminated water is intercepted by a stream during the course of travel (Romero, 1972). If impregnated with bacteria and viruses by septic tanks or leaky sewers, partial areas, which shed surface waters to streams, may become contaminated, creating a health hazard.

BACTERIA TRAVEL 50'-100' IN GROUNDWATER.

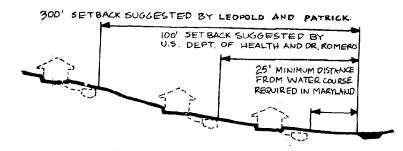


VIRUS AND BACTERIA TRAVEL

Figure 10

#### Setbacks

The United States Public Health standards suggest a minimum setback of 100 feet between wells or watercourses and septic tanks (Romero, 1972). The Maryland Health Department requires a minimum setback of 25 feet from wells and watercourses. Romero (1972) recommends a 100 foot setback from all wells and water bodies unless it can be shown that a shorter distance will not increase the probability of contamination. Aquatic biologists and hydrologists realize that circumstances dictate different setbacks, and that a setback of 300 feet should be recognized as a standard if all bacteria and nutrients are to be filtered out by the soils, (Leopold, 1968; Patrick, pers. comm.)



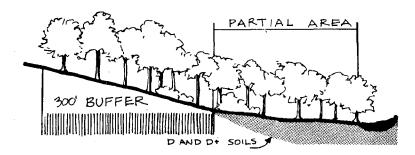
VARIOUS RECOMMENDED SETBACKS

Figure 11

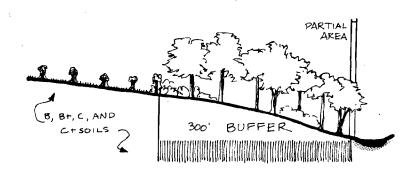
Using partial areas increases the accuracy of determining the length of setbacks from water bodies and aquatic systems. The setback should be delineated from the landward edge of the partial areas (D and D<sup>+</sup>soils). Thus, while the setback is standard, the distance from the water body is variable depending on the width of the partial area. As noted above setbacks less than 50 feet will probably not filter out the biological and nutrient contaminants. Setbacks over 300 feet increase the adequacy.

The following illustrations show the considerations of soil character and vegetation used to evaluate the adequacy of aquatic buffer zones during the field survey of sites for this study.

# ADEQUATE

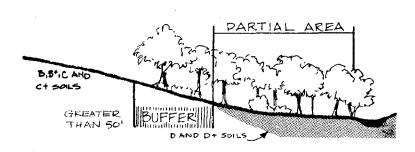


WIDE STREAM-SIDE PARTIAL AREA

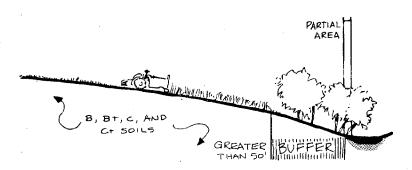


NARROW STREAM-SIDE PARTIAL AREA

# QUESTIONABLE



WIDE STREAM-SIDE PARTIAL AREA

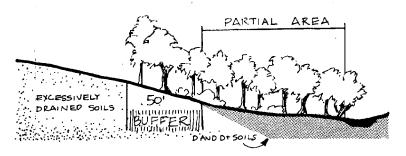


NARROW STREAM-SIDE PARTIAL AREA

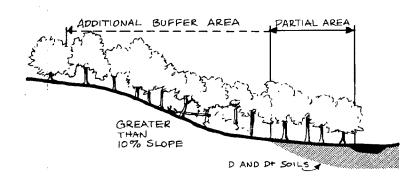
Figure 12

4.4

# QUESTIONABLE (POSSIBLY INADEQUATE)



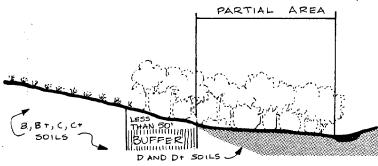
MINIMAL SET-BACK NEAR EXCESSIVELY DRAINED SOILS



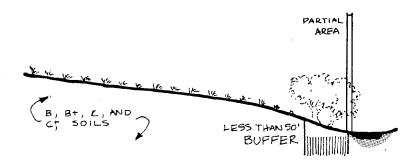
# STEEP SLOPES

WHEN SLOPES GREATER THAN 10% OCCUR NEAR OR ADJACENT TO PARTIAL AREAS, THEY MIGHT BE INCLUDED IN THE SUFFER ZONE. EROSION AND HIGH RUNOFF MAKE THESE AREAS COURCES OF POLLUTION.

# INADEQUATE



WIDE STREAM - SIDE PARTIAL AREA



NARROW STREAM-SIDE PARTIAL AREA

Figure 13

### **GLOSSARY**

Aquatic Buffer Zone - a band of vegetation contiguous with wetlands and watercourses which protects an aquatic system from excess runoff, erosion and contamination from non-point sources of pollution such as fertilizers and pesticides. The width of vegetated land necessary to adequately buffer the aquatic system varies, depending on the soil's ability to store water and the type and extent of the vegetation in the buffer.

Aquatic System - a wetland, watercourse, or water body and contiguous areas with D or D+ soils.

Bacterial Danger Zone - soil between the highest water table level and one foot below the lowest water table level; where conditions are ideal for bacterial growth.

Basal Area - the area, usually measured in square feet, of the cross-section at breast height of a single tree or of all trees in a stand.

Baseflow - stream flow derived from deep percolation of infiltrated water that enters the permanently saturated ground water system and discharges into the stream channel.

Buffer - a limited use area between a developed area and a protected area.

Categories - a division within a parameter used for the purpose of scaling.

Class - a group of areas considered as a unit (e.g., wetlands, forests, fields).

<u>Community</u> - any assemblage of populations living in a prescribed area or physical habitat.

Contamination - befoulment through contact with a pollutant (e.g., pesticide, herbicide, toxic chemical, oil residue, bacteria, sediment).

Contiguous Land Use - the type of use being made of land adjacent to and bordering a natural area.

<u>Critical Area</u> - areas where man's activities can have a relatively severe impact on natural systems. Critical areas may also be habitats which are infrequently found in a state or in the nation as a whole.

DBH - tree diameter at breast height (4.5 feet above the ground).

Detritus - particles of plant matter in varying stages of decomposition.

<u>Disturbance</u> - a disruption, or perturbation, of an ecosystem resulting from human activity.

<u>Diversity</u> - the number of different vegetation types, animal species or physical features (e.g., streams, scarps, bogs) which the natural area contains.

<u>Drainageway</u> - a pathway for watershed drainage, characterized by wet soil vegetation; often intermittent in flow.

Edaphic Climax - where topography, soil, water, fire and other disturbances are such that the climatic climax cannot develop.

Endemic - a species of limited geographic extent.

<u>Erodibility Coefficient</u> - (K factor) - the erosion rate per unit of erosion index for a specific soil in continuously cultivated fallow ground on a 9% slope, 72.6 feet long. This factor is used by the Soil Conservation Service to calculate the erosion from a particular soil.

Exotic species - any plant or animal species not naturally a member of the plant community in which it is found.

Fauna - a collective term for the animal species present in an ecosystem.

Floodplain - a flat, low-lying area bordering a river or stream which is flooded only at times of high water.

Flora - a collective term for the plant species present in an ecosystem.

Floristics - plant species composition of an area.

Ground flow - the movement of water within the ground.

Ground water - that part of the subsurface water which is in the zone of saturation.

<u>Habitat</u> - the area of residence for an animal species or a community of species.

Home range - the area to which individuals, pairs, or family groups of vertebrates and the higher invertebrates restrict their activity.

<u>Infiltration</u> - the flow or movement of water through the soil surface into the ground.

Mottling - colored spots in soil horizons which indicate the existence of fluctuations in the ground water level.

<u>Natural area</u> - areas where at present natural processes predominate and are not significantly influenced by either deliberate manipulation or accidental interference by man.

Natural integrity - the degree to which a natural area is characterized by the natural regeneration of vegetation, mature or stable vegetation and the absence of man-induced disturbances.

Natural soils group - a new classification system of the State of Maryland's Department of State Planning which groups soils into similar major properties and features. The soil typologies of each county are regrouped around six categories of interest: agriculture, productivity, erosion susceptability, permeability, depth of bedrock, depth of water table, and stability. In general, the natural soil groups are arranged in order of increasing limitation for most uses.

Occurrence - the relative frequency of the vegetation type(s) or natural features in a natural area within the context of its frequency of occurrence on the Delmarva Peninsula.

Overland flow - water flowing over the ground surface.

Parameter - a topic whose information is amenable to collection and analysis.

<u>Partial area</u> - dynamic, saturated, often shallow, stony or compacted areas near streams which contribute large volumes of runoff during a storm.

<u>Perched water table</u> - water table above an impermeable bed underlain by unsaturated rocks of sufficient permeability to allow movement of ground water.

<u>Percolation</u> - movement under hydrostatic pressure of water through the interstices of the ground.

<u>Primary productivity</u> - the amount of organic matter produced by photosynthesis.

Quadrat - a sampling area, usually square, of relatively small but consistent size.

Return flow - subsurface flow which intersects the ground surface and emerges as a spring or seep.

Runoff - the discharge of water through surface streams, expressed usually in units of volume such as gallons, cubic feet or acre-feet.

Runoff potential - the potential of the soil to shed rainwater. The runoff potential rating is based on soil catenas. Soils are grouped into seven runoff potential rating categories according to internal drainage, depth and texture of the soil as well as subsurface soil conditions. The rating system enables hydrologists or land management personnel to classify the soils hydrologically. D and D\*soils have the highest runoff potential while A soils have the lowest. This system not only expands S.C.S. hydrologic soil groups but also includes relevant soils information to reclassify certain soils based on recent research.

Saturated overland flow - surface water flowing over saturated soils near streams and drainage ways.

<u>Security</u> - the probable period of time during which no significant maninduced, direct or indirect alteration of a natural area is foreseen.

 $\underline{\underline{\text{Sedimentation}}}$  - the process of gravitational deposition of soil and other particles transported by water.

Soil series - a group of soils developed by the same combination of genetic processes. Its horizons have similar differentiating characteristics and arrangement in the soil profile and soils have developed from the same kind of parent material. Except for the "A" horizon texture (which is used to classify soil series into types) all soils having similar physical, chemical and morphological characteristics such as structure, texture, pH, base saturation, organic matter content, topographic position, drainage, depth, color, parent material and horizon thickness, type and arrangement belong to the same series.

Soil series are named for the geographic location where they were first described. Hence names such as Pocomoke, Sassafras, etc.

Soil type - a subdivision of the soil series based on the texture of the "A" horizon. Soil individuals belonging to the same type have similar characteristics as required by the soil series as well as the same surface texture. Soil types derive their name by adding the surface texture to the series name.

Subsection- a division of a natural area which reflects a discrete vegetation type, site-type or natural feature.

Substrate - layer beneath the soil surface.

Subsurface flow - water flowing through substrate, often along impeding layers (fragipan) in the soil.

<u>Succession</u> - a systematic series of species replacement in a biological system.

Transpiration - giving off of moisture and gases through the surface of leaves and other parts of a plant.

Trophic level -a step in the food chain.

Type - a subdivision of a class, a group having distinguishing characteristics, (e.g., pond, marsh, swamp; oak-beech, mixed oak, oak-pine).

<u>Uplands</u> - sites where the soil is dry or moist most of the year including ridges, upperslopes, midslopes, lowerslopes and well drained stream terraces.

<u>Vegetation</u> - the mosaic of plant communities in the landscape.

<u>Vegetation structure</u> - the density and distribution of leaf surfaces vertically and horizontally. Canopy, understory, shrub and herb layers are common descriptions of vegetation structure.

<u>Vegetation types</u> - an assemblage of plants consisting of particular species composition. The vegetation type is named for the dominant or co-dominant species. Vegetation types such as "Oak-Hickory" or "Bald cypress", may include as many as 20 different species of trees, as well as numerous shrubs and herbs. In some cases the transition between adjacent types are gradual; therefore the description given the vegetation type is more typical of the center of the type than its edge.

<u>Water table</u> - the highest level at which the soil or underlying rock material is wholly saturated with water. In certain places a perched water table may be separated from a lower water table by a dry zone.

Well drained soil - soils nearly free of mottling and commonly of an intermediate texture.

Wetland - any area where the water table stands at or above the land surface for at least part of the year. Wetlands are described according to the degree of wetness and the type of vegetation which the site supports.

